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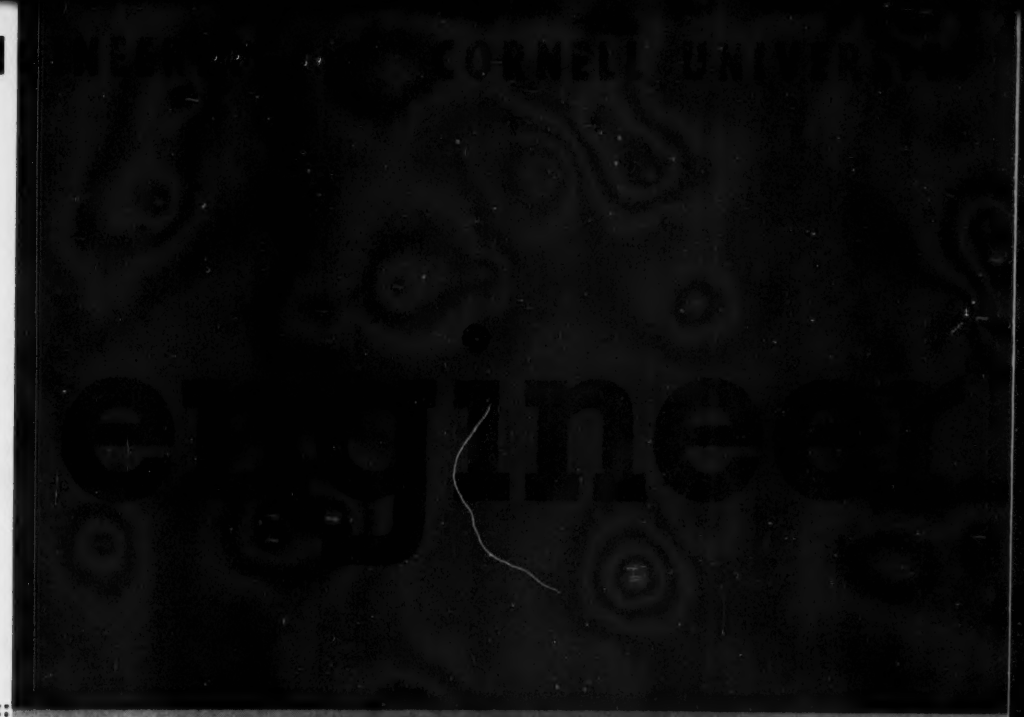

JANUARY, 1955

VOL. 20, NO. 4

25 CENTS

John A. Bauscher, *Class of '43*
speaks from experience when he says . . .

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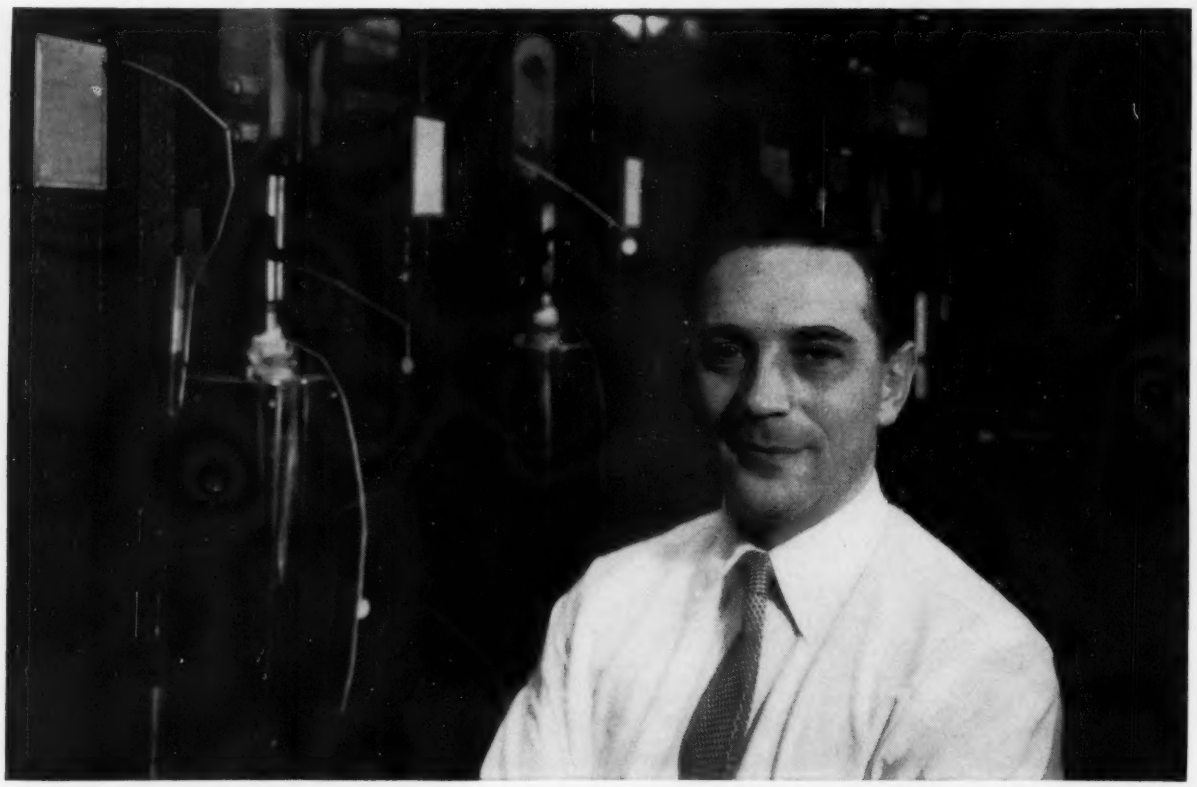

JOHN BAUSCHER graduated from college in 1943 with a B.S. degree in Metallurgy. After a stint in the Navy, he returned to college as a metallurgical research assistant. In 1949 he received his M.S. in Metallurgy and then came to work at the U.S. Steel Applied Research Laboratory. After just four and a half years, Mr. Bauscher had progressed to Division Chief for Sheet Products Development – responsible for the improvement of present sheet steel products and the development of new and improved types.

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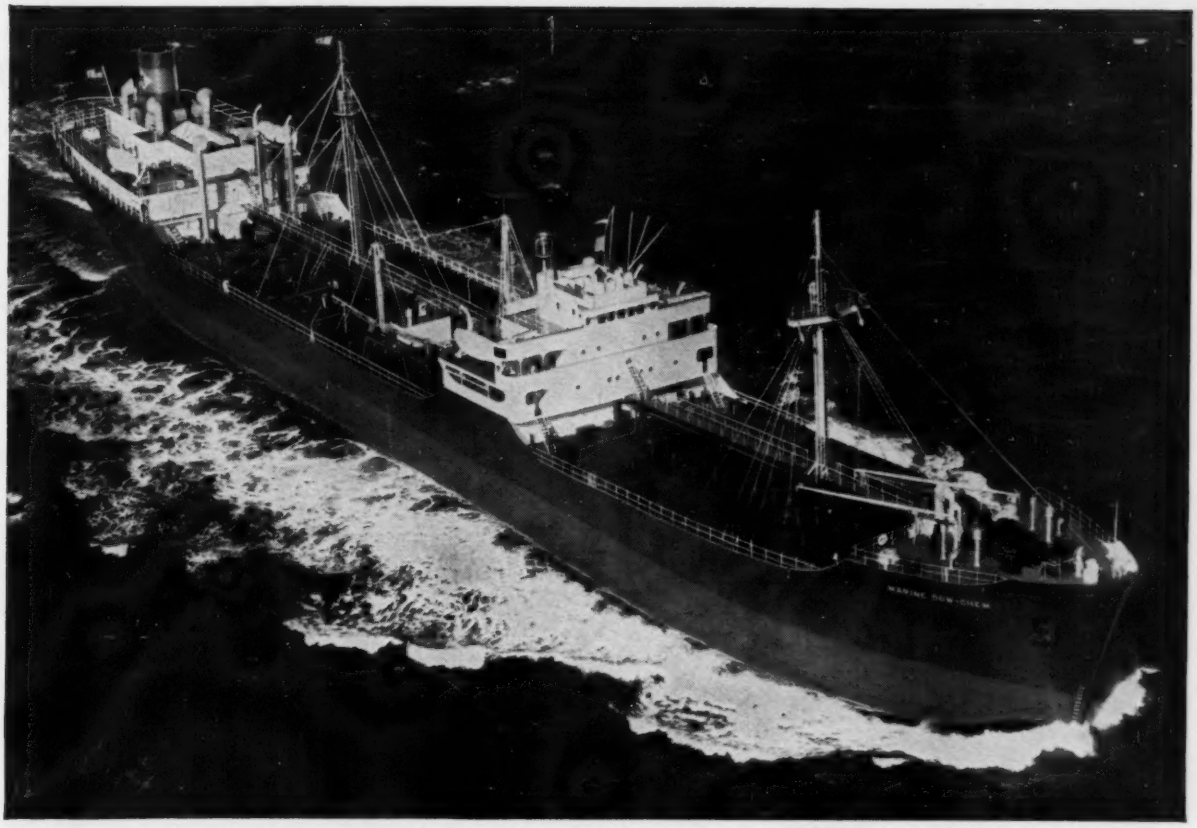

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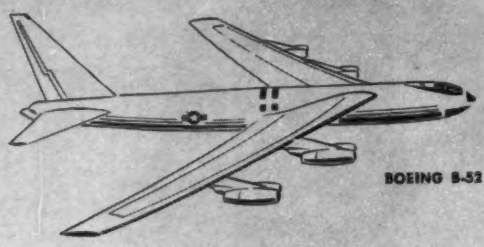

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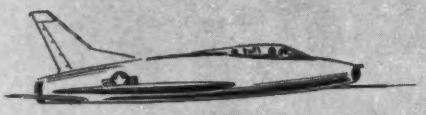

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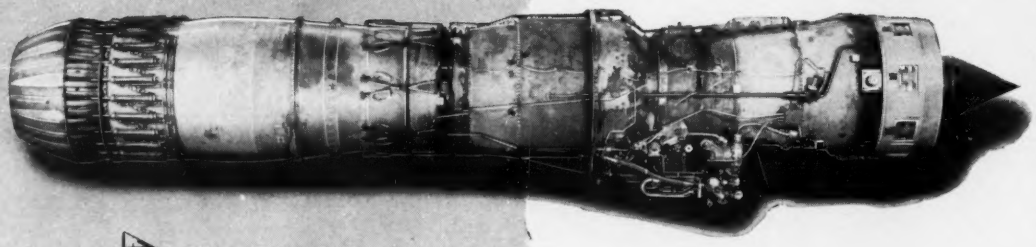

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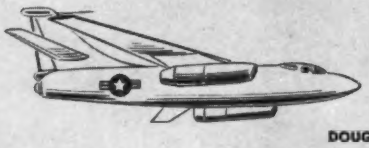

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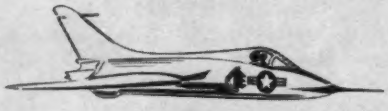

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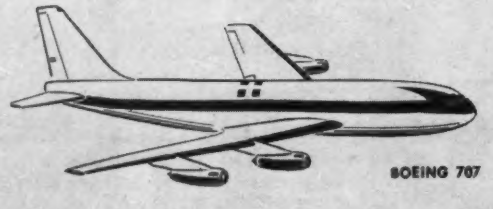

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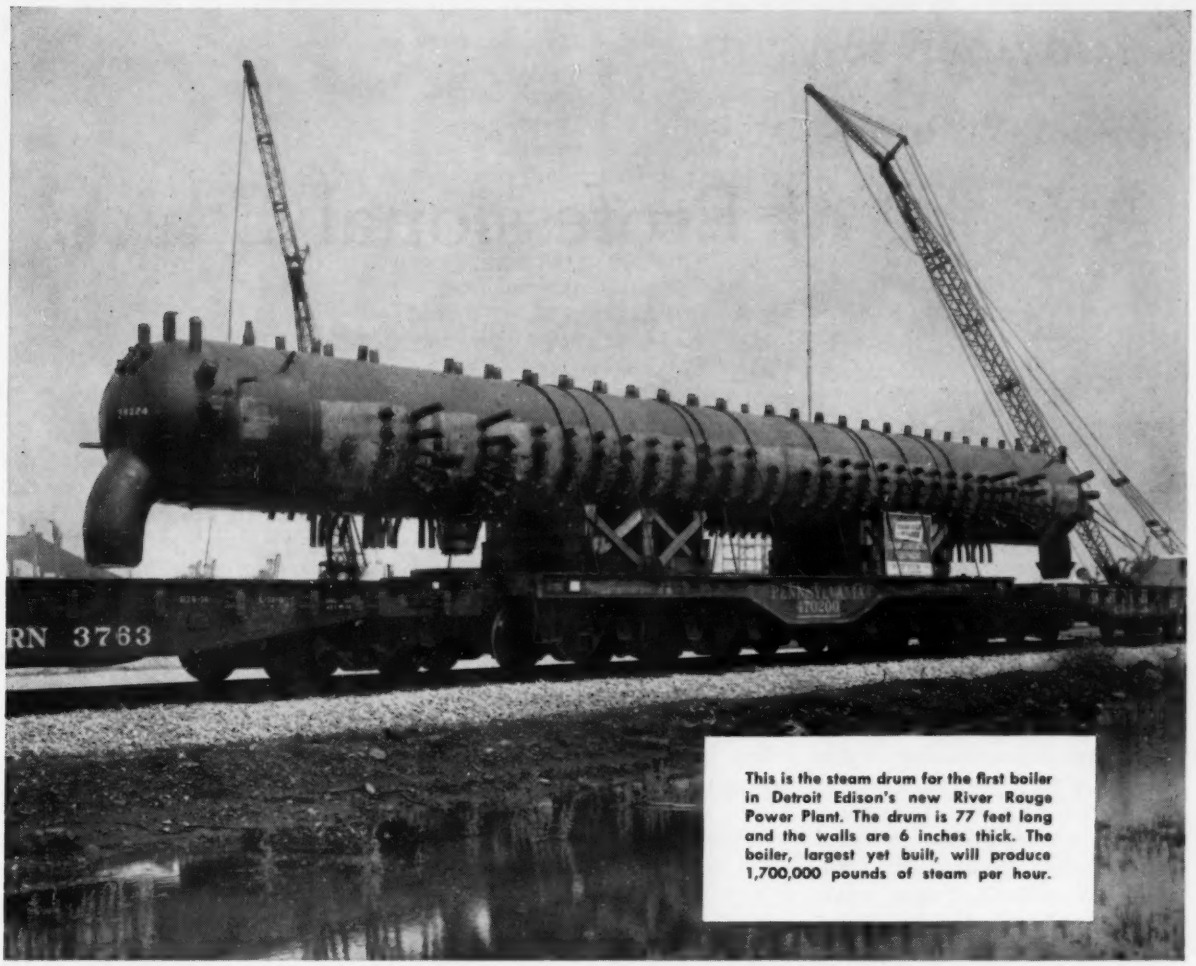

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Editorial:

A Code of Professional Ethics?

by M. D. MORRIS, C.E. '44

To kill a snake, one cuts off the tail close to the ears! Similarly, malignant intrusions upon the normalcy of the engineering profession must be spiked at their origin. Words on a page are unenticing—conversation serves only to pass time unless credence is given to some of the things said.

The moot basic question: "Is a Code of Professional Ethics desirable?" would net a negative reply in an ideal civilization. But in this world that we know, there is only one answer—"It is!" Now, why? For the layman, I'd say it was a peg on which to hang his faith. More professionally, it is a datum plane from which all other values are defined.

Disregarding Webster's definition, momentarily let us examine the values of things that do—or do not—come to mind upon hearing the word "ethics." This is the name of some imaginary beacon in whose channel we run our working lives; a sort of golden rule for moral behavior amongst ourselves. We really reflect often enough, "Would I want this done unto me?" Until the shiny time arrives, this "beacon" must be replaced by a physical track. Not extra laws compelling more phases of our already over inhibited existence; but a set of guideposts for our daily transactions.

People look to philosophers, physicians, poets, and lawyers to mold the living society. But the functional physical world, upon which the rest depend, the tangible world the average citizen sees, is shaped by engineers who cannot chance clay feet. Sharp practice in any form is to be frowned upon by all people.

The human engineer's needs for food, clothing and shelter are on a higher plane because by his own labors in education and experience he has risen from the mundane. His conduct of life should be of becoming starry-eyed. The word "professional" implies the earning of compensation for one's work. The "engineer", not the "man" assumes a social responsibility and moral obligation to the world that recognizes his ability and pays his fees. Altruism shouldn't be a deterrent from financial success nor should engineering be a stepping stone to "an easy buck." Too many engineers work too hard and too long to be hanged by a stray few. Lex populi condemns en masse, and the stigma of a fiasco is never gone with the night.

Aristotle called ethics ". . . the right and wrong in conduct." I believe "right" is the procedure in order for the good of the greatest number, while not harming those it does not help. "Wrong" then, becomes any deviation from that procedure regardless of magnitude. Here exists a hairline boundary without twilight zone or room for rationalization. These seem positive statements but in an argument of this nature a definite stand must be taken lest the entire effort become innocuously worthless.

Ethical living comes about through correct thinking, which is acquired by working for it in conjunction with a form of attrition I call subtle infiltration. It comes by example, practice, observation, and by an inner sense of righteousness that enables us to live with ourselves.

Academically, ethics cannot be taught as a subject. It can be defined and discussed, but no one can be caused to believe these things merely by sitting with a book and a docent for three hours a week. Ethics must be given as a natural part of our daily lives, to be absorbed subconsciously, by subtle infiltration, along with the academics. One outstanding example of this is the Honor System in the Civil Engineering School here at Cornell. The absence of examination proctors removes the competitive challenge of organized cribbing. On signing the pledge, "On my honor I have neither given nor received aid in the completion of this examination," he also assigns a value to his word as a person.

Violation of this system are referred to an Honor Committee comprised entirely of elected students. Transgressors are generally dismissed from the school. In unusual circumstances an offender is allowed to continue on probation; a recurrence in such cases is an unknown item.

Learning by living, this self-operating honor code is in fact, not an experiment, which builds character while serving as a screen for the profession. An expelled violator often goes on, elsewhere, to profit from this experience and become a rock of confidence. Or else, by this incipient elimination, engineering is spared the later chagrin of coping with a chronic wayward.

Knowing that the wisdom and philosophical talent within our circle has drafted a Code of Professional Ethics which we have granted we need, we must also attach thereto a set of firm, sharp teeth. Without the proper defer-

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ence and trepidation, our code is worth nothing. A basis of participation commanding no respect could so damage the structure it should bolster, it might well become disasterous enough to destroy our professional foundations entirely.

Here vacillation ceases. We must elect periodically from our ranks a group to keep the strays in—or out! We must empower this group and abide by its decisions. Much as the students uphold their honor system, we adult engineers must adhere tenaciously to the ideals we've set for ourselves.

In thinking of cause and effect, we might ask if our high-geared atomic age has so dulled our senses that, in our daily lives, we have *created* the need for our code. Have we so reversed our values that to the next generation an idealist is someone "different." What will his grandchildren think?

No member of the engineering profession lives in a vacuum. Unethical practice is akin to the cold germ in the atmosphere; forever present, waiting only for the resistance to ebb low. A bit of the mold of life rubs off on everyone. Just how much is a function of the individual. This is the quality that separates the sheep from the goats and engineers from sheer professionals.

Between altruistic idealism and the utter materialism of our professional world exists an ethical medium patterned on the code. Without some direction, some specification for ordinary working conduct, our own mutual trust, and the public faith in the builders of their world race hand-in-hand down the dusty distance to oblivion.

Truly there should be no need for such a code. But our society is still quite human and very remotely idealistic. Consequently a schedule for human behavior for a highly specialized category of individuals is most in order until such time that we can convince ourselves by acts, not words, that we have become Utopian. Until then we must be practical; to show human engineers the way, a Code of Professional Ethics is definitely desirable.

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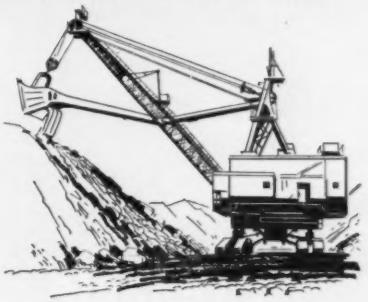

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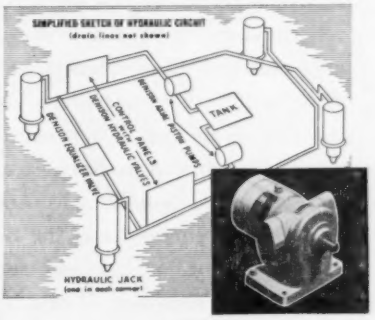

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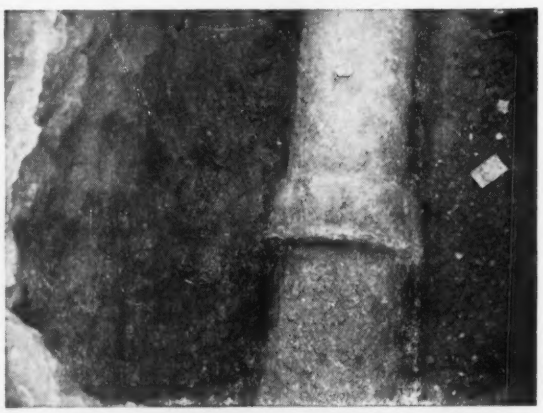

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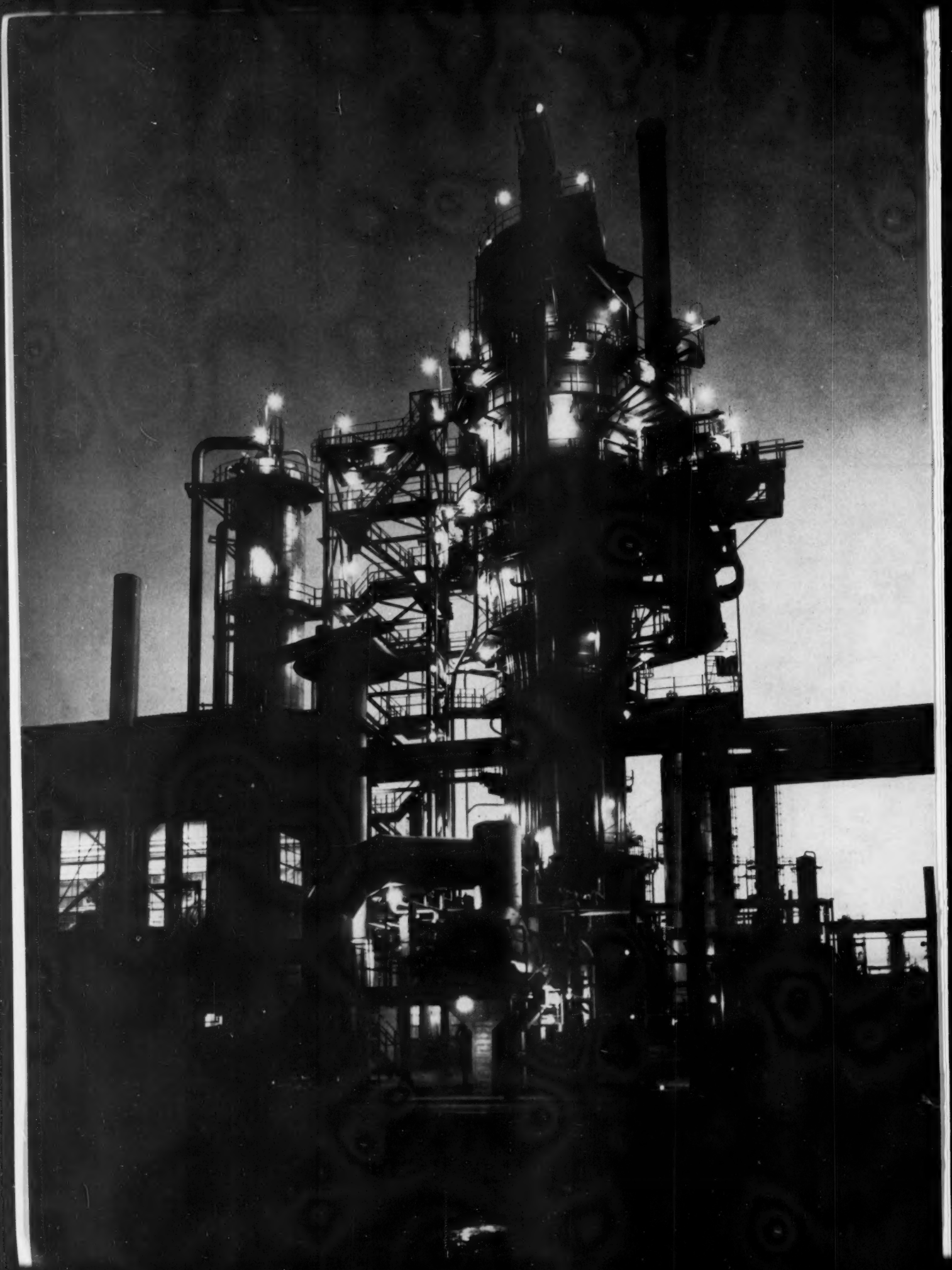


The Catalytic Cracking Process

by JOHN F. SCHMUTZ, ChemE. '55

The main purpose of catalytic cracking is to convert products ranging from naphthas to reduced crudes into high value products, principally gasoline. Catalytic cracking has largely superseded thermal cracking as a method of upgrading petroleum stocks and has made possible the utilization of large quantities of low value fuel oils which accumulate in crude oil processing.

Most of the cracking processes used commercially today have come into production since World War II. Basically the catalytic cracking is the splitting of large petroleum molecules in the presence of a catalyst. During the cracking a significant amount of polymerization of the smaller molecules also occurs. Products from a typical gas oil feed would include gasoline, light and heavy catalytic gas oils, butanes and butylenes, propanes and propylene, ethane and ethylene, methane, hydrogen, and coke. Butylenes and propylene are polymerized and combined with the cracked gasoline and straight run gasoline. This mixture is further blended with such compounds as toluene, cumene, and tetraethyl lead which further increase the octane number of the product. Light gases such as methane, ethane, propanes, and butanes are used in the manufacture of petrochemicals or in various other applications in the refinery. Coke and tars deposited on the catalyst during the cracking are burnt from the catalyst, providing steam for other processes and heat of cracking for the catalytic process itself.

Night operation of the Othoflow Fluid Catalytic Cracker at the Toledo, Ohio, refinery of the Pure Oil Company.
—M. W. Kellogg Company

Catalytic Cracking

Catalytic cracking consists essentially of two steps: the cracking reaction and the catalyst regeneration. In the cracking step, vapor, liquid, or a mixture of liquid and vapor are brought into contact with a hot catalyst causing vaporization and splitting of the hydrocarbons. The reaction itself is endothermic and the heat of reaction is supplied by the catalyst. Reaction temperatures vary from 750 to 950°F; reaction pressures vary from 2 to 20 psi. The severity of cracking is largely controlled by the catalyst circulation rate and the reactor temperature; higher temperatures and higher circulation rates lead to a greater portion of light gases. Combined with the other independent variables such as catalyst to oil ratio, liquid feed rate, recycle ratio, and catalyst temperature, these variables make possible the use of wide variety of feed stocks.

Two of the most widely used catlaysts are natural clay and a mixture of silica and alumina. The clay catlaysts consists of cylindrical pellets about one quarter of an inch long. The silica-alumina catalyst, developed by the Socony-Vacuum Oil Company, has a small percentage of chromic oxide added to the catalyst to improve its regeneration characteristics. The catalyst is produced in the form of beads ranging from 4 mesh to 8 mesh. The catalyst has an activity of 34 by the CAT-A method and reaches an equilibrium value of 28 to 30.

The use of liquid feed alone or in conjunction with vapor feeds has three distinct advantages; (1) heat of combustion of the coke is used to heat the feed without a preheater, (2) feed can be drawn directly from storage instead of from a feed preparation unit, and (3) a vacuum feed preparation unit can be used permitting the recovery of a larger portion of the heavier fractions from reduced crude. Since many of the heavier fractions in the reduced crude cannot be vaporized at atmospheric pressure without harmful degradation and coking in the heater tubes, these fractions must be vaporized at low pressure, condensed, and fed as a liquid to the cracking unit.

Catalyst Regeneration

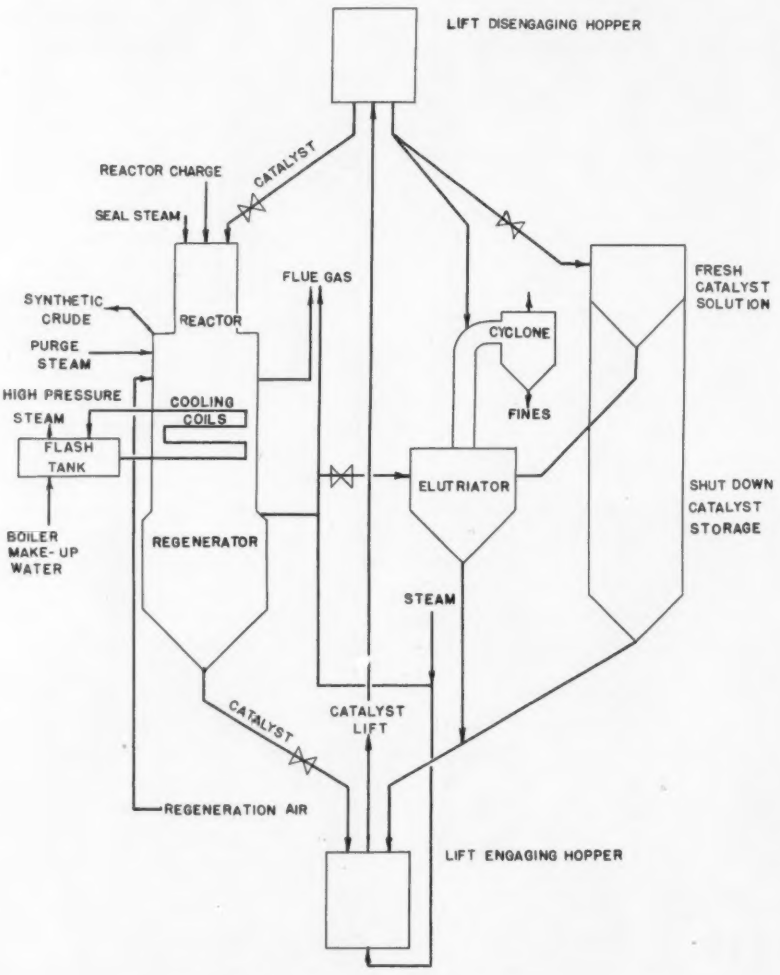
During the cracking reaction coke and heavy tars are deposited

on the cracking catalyst. Coke and tar deposition is largely a function of the reactor operating conditions; typical values are 1 to 2 per cent of the catalyst weight before regeneration and a few tenths of a per cent residue after regeneration. This coke and tar has two disadvantages; first, it decreases the activity of the catalyst, and, secondly, it increases the breakage of the catalyst. With catalyst costing several hundred dollars per ton, catalyst attrition becomes an important factor in cracker operation; under normal conditions this attrition is about 0.3 pounds per barrel of charge for a 15,000-barrel-per-day-unit or about two tons per stream day.

Coke and tars are removed from the catalyst in a regenerator which, in effect, is a large reactor through which air is blown to burn off the residue. Combustion air may be fed directly to the regenerator or preheated first in a line burner; in the line burner propane or some other gas is burnt directly in the air line. Combustion air is usually at a relatively low pressure between 5 and 10 pounds gauge. Heat evolved in the burning of the residues is absorbed by the catalyst; this absorbed heat eventually provides the heat of cracking in the reactor. The maximum temperature permissible in the regenerator is limited largely by the materials of construction and design of the regenerator, and in newer units is in the neighborhood of 1300°F. Localized hot spots can also cause deterioration of the catalyst.

To maintain safe operating temperatures and control the burning rates in the regenerator, sets of cooling coils are placed in the regenerator. Water is passed through these coils, then flashed in a high-pressure steam drum. The high-pressure steam may be used to operate the air blower, pumps, and compressors. Low pressure steam from the pump and compressor exhausts is used for purging and sealing in the reactor.

Flue gas from the regenerator is used to lift the regenerated catalyst to the top of the reactor, or it can be exhausted directly. Part of the flue gas can also be used in the elutriator, a unit on the cracker used to separate the fines from the catalyst by blowing a stream of gas countercurrently to the catalyst.



Flow diagram of Houdriflow catalytic cracking process.

Typical Process

One of the more important catalytic cracker designs is the Houdriflow, designed by the Houdry Process Corporation. In the Houdriflow units vapor, liquid, or vapor-liquid mixtures are charged to the reactor where they are contacted intimately with the catalyst. Most of the catalyst is admitted to the cracking zone through an annular orifice which surrounds the hydrocarbon feed nozzle. The remainder of the catalyst enters the cracking zone through a series of pipes set around the periphery of the reactor; these pipes maintain the catalyst bed level and control the space velocity. Cracked vapors at the bottom of the reactor are removed through a disengager and sent to a synthetic crude tower. The catalyst from the bottom of the reactor is finally purged with low pressure steam to remove most of the remaining hydrocarbons; the steam and hydrocarbon mixture joins the main product stream.

The reactor and regenerator are combined in one outer shell. Catalyst from the purge section is passed countercurrently to air in the regenerator and coke and tars are removed from the catalyst. The regenerated catalyst flows to the lift engaging hopper where it is forced to the top of the cracking unit by a stream of flue gas and steam from the thermocompressor. From the lift disengaging hopper at the top of the unit, catalyst flows through a seal leg to the reactor where it again contacts the charge. The purpose of the seal leg at the

top of the reactor is to maintain reactor pressure. Steam is injected into this leg to maintain the seal and prevent hydrocarbons from escaping.

About five per cent of the catalyst is withdrawn continuously from the system and sent to an elutriator where the fines are removed by a countercurrent blast of flue gas. A shut-down catalyst storage and a fresh catalyst storage are also provided on the unit. Normal operating conditions for the reactor are: 850 to 925°F, 5 to 10 psig, 1.5 to 4 space velocity, and from 3 to 7 catalyst to oil ratio.

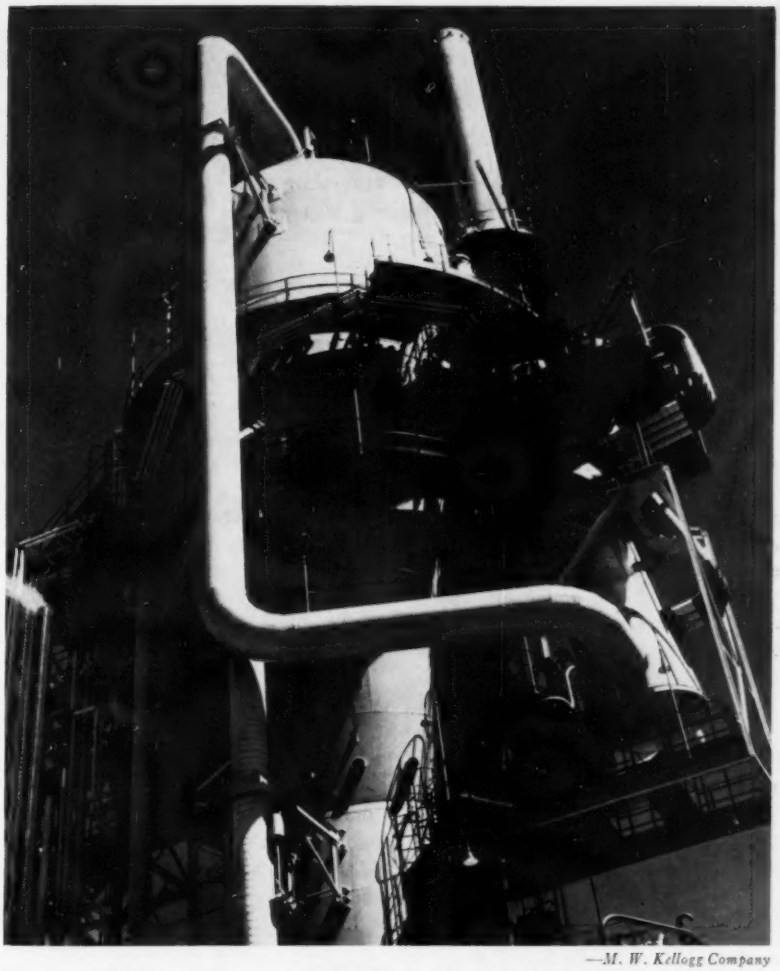
Some Houdriflow units have operated with as high as 90 per cent conversion with total yields based on fresh charge of 78 to 80 volume per cent of 10-pound RVP gasoline. Total Houdriflow capacity in operation and under construction is approximately 250,000 barrels per day.

TCC

In principle the Thermofore Catalytic Cracker, TCC, developed by the Socony-Vacuum Oil Company is similar to the Houdriflow. In the TCC unit the reactor and regenerator are separate units. The regenerator, which is placed below and to one side of the reactor, is cylindrical with a hole through the center which the catalyst lift pipe passes. Combustion air at about 2 psig is injected into the regenerator; part of the air flows up the regenerator countercurrently to the catalyst, while the remainder flows out the bottom flue-gas vent. Cold combustion air is usually used to gain maximum carbon burning capacity.

In one design the main stream of catalyst is fed as a falling curtain at the center of the reactor, while the remainder of the catalyst is fed through pipes set around the walls of the reactor to maintain the bed level. Liquid feed is sprayed into the falling curtain of catalyst and vapor enters in the space above the catalyst bed. Pressure in the reactor varies from about 9 to 13 psig at the top of the reactor to 6 psig at the bottom.

TCC units now in operation or under construction have a total capacity of over 500,000 barrels per day. Individual units vary from 1600 barrels per stream-day with a carbon burning capacity of 1100 pounds per hour to 28,000 barrels per stream-day with a carbon burning capacity of 29,000 pounds per hour.



—*M. W. Kellogg Company*

View of the regenerating section of the Orthoflow B Fluid Catalytic Cracker at the Clarkson, Ontario, refinery of the British American Oil Company, Ltd.

UOP Process

The UOP fluid catalytic cracking process developed by the Universal Oil Products Company features a totally liquid feed. This process is employed primarily to convert distillate oils into high octane gasoline and to reduce overall refinery fuel oil production. Charging stock can include either virgin or cracked naphtha, kerosene, light gas oils, wax distillates, atmospheric and vacuum heavy gas oils, and distillates from viscosity breaking or coking.

Gas oil feed is charged into a stream of hot regenerated catalyst where it is vaporized. The charge and catalyst pass to the reactor where the cracking is completed. Product vapors are separated from entrained catalyst at the top of the reactor by a cyclone separator; spent catalyst from the bottom of the reactor is sent to the regenerator where the coke and tars are burnt off the catalyst with air. A cyclone separator is also used in the regenerator to separate any entrained catalyst from the flue gas.

At present there are nearly 60 UOP cracking units in operation or under construction with a combined capacity of over 400,000 barrels per day. Units vary from 1400 to 35,000 barrels of fresh charge per day.

Orthoflow

A fourth type of cracking unit is the Orthflow catalytic cracker developed by the M. W. Kellogg

(Continued on page 40)

Keeping Up To Date On

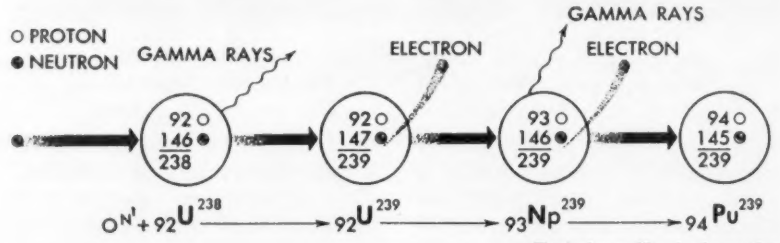
ATOMIC ENERGY

by STUART BRAUN, ME '57

One of the final accomplishments of the regular session of the 83rd Congress was the formulation of the Atomic Energy Act of 1954; an examination of this and other atomic energy legislation, along with an investigation of the processes which these laws are intended to regulate and protect, would be quite appropriate, for the American Atomic Energy Program is history's largest industrial undertaking. And, from a personal standpoint, the U.S. government has spent over $14 billion of our money to develop the potentialities of the atom to insure our security.

For almost one year after the first atomic bombs fell on Japan to end World War II, a concrete atomic energy program in the United States was non-existent, for the Congress had not yet defined in the form of legislation American atomic energy policy. The Manhattan Engineering Project, established in 1941 to develop the first atomic bombs, was a wartime undertaking, created by Executive Order, not by Congress. For want of secrecy, all operations concerning the project were clandestine. But with the end of war, the veil of secrecy was lifted, and Congress was left to work out a plan for the control of the production of atomic energy.

There was little question as to the purpose of the legislation; the federal government was to be empowered to control production of atomic energy, to be required to obtain ownership of all materials from which atomic energy is produced, and the facilities for its production. Complete governmental supervision and control of all processes and facilities was necessary for obvious security reasons for one; and, more important, in the words of President Truman, "The discovery with which we are dealing involves forces of nature too dangerous to fit any of our usual concepts." Private enterprise could not yet be trusted with this new force of atomic energy, and moreover, did not have the resources for research and development which the U.S. government possessed.



—Westinghouse Electric Corporation

Fig. 1. Pictorial representation of the transmutation of U-238 into fissionable Pu-239. The U-238 nucleus absorbs a neutron and emits gamma rays to form U-239, which in turn shoots out a high-speed electron to form Np-239. This unstable isotope then emits more gamma rays to form plutonium.

Atomic Energy Law of 1946

The Atomic Energy Law of 1946, signed by the President on August 1, created a five-man Atomic Energy Commission, and bestowed upon it greater powers than had possessed any government agency before it. The Commission was provided with a complete monoply in the atomic energy field.

1) Organization.
   a) The five members of the Commission are appointed by the President and confirmed by the Senate.
   b) The Commission is composed of four Divisions: Research, Production, Engineering, and Military Application, each headed up by a Director, and all under the supervision of a General Manager.
   c) A General Advisory Committee, comprised of prominent scientists, engineers, and businessmen from civilian life, advises the Commission on matters relating to the production of and research in, the atomic energy field.
   d) Representatives of the Armed Forces form a Military Liason Committee to advise the Commission on all facets of the military applications of atomic energy, such as manufacture, storage, and utilization of bombs. The Committee may appeal to the Secretary of Defense and ultimately to the President if its recommendations are disregarded.
2) Production of Fissionable Material.
   a) Definition

      Fissionable material is defined by the Senate as "Plutonium, uranium enriched in isotope 235, or any other material which the Commission determines to be

Gaseous-Diffusion Plant K-25 at Oak Ridge, with Auxiliary Process Plant K-27 in foreground. Built during World War II, K-25 is the largest continuous process plant under one roof in the world.

capable of releasing substantial quantities of energy through nuclear chain reaction of the material." This term will be more fully explained below.

b) The Commission is the sole owner of all facilities used in the production of fissionable material and is authorized to operate these to produce the above materials. Provision is made for the loaning out of fissionable material and the construction of small-scale facilities, that is reactors for the purpose private research. The Commission limits the size of reactors which can be built to those well below the size necessary to produce material enough for the construction of an atomic bomb.

3) Control of Material.

a) The Commission is the sole owner of all fissionable materials produced in the U.S., and is directed to purchase all source materials such as uranium ores mined in the U.S. and also those which can be procured as are mined in other nations.

4) Military Applications

a) The Commission is authorized to engage in the production of and research in, atomic weapons.

5) International Arrangements and and Control of Information.

a) Cooperation and exchange of information with other nations as concerns the military and industrial applications of atomic energy are prohibited. Thus arrangements with friendly nations in the atomic energy field are out of the question; wartime cooperation with Britain and Canada was not continued.

6) Research

a) The Commission is directed to insure continuance of private and public research in the atomic energy field. To this end, the AEC supports research activities at the Argonne National Laboratory at Chicago, the Brookhaven National Laboratory at Chicago, the Radiation Laboratory at the University of California, the Oak Ridge National Laboratory, and at the University of Rochester. In addition, the Commission has contracted with over 100 universities and research institutes to conduct research programs designed by its experts.

The Act Of 1954

In August of last year, the government monopoly on atomic energy development was ended, although it still remained under strict federal supervision. The AEC was authorized to license private and public applicants to operate facilities for the production of nuclear materials, that is construct reactors of sufficient size to produce large amounts of fissionables. This provision, in particular, opens the way for the development of atomic power for peacetime use by private utility companies; of course, a multitude of other uses is contemplated. The AEC continues to own all energy-yielding materials, redefined to include fusibles as well as fissionables, even though produced in private hands. Further, the AEC is empowered to lease out large amounts of special nuclear materials to licensees for industrial uses.

Much of the Congressional debate on the Bill centered around the issue of public power, its proponents claiming that the legislation did not provide for its implementation. A compromise was reached whereby the door was left open for public atomic power along the lines of TVA, but specific authorizations or grants of funds to carry it out were not provided for; the AEC, although forbidden itself to produce commercial power, may sell energy obtained as a by-product from its various military production or experimental facilities; it is also authorized to erect a "demonstration", or pilot experimental power plant and to sell its output in the power market, and it may license any other governmental agency to produce commercial power.

The international implications of the Act are far-reaching. The President is authorized to initiate and conclude agreements with single nations or regional defense groups for cooperation in the development of atomic energy for peacetime uses, and for the pooling of information as regards atomic weapons. The President has already moved to establish arrangements of this nature with Great Britain, France, Canada, Austrailia, and South Africa.

The so-called "Dixon-Yates" deal, a subject of fierce controversy, actually was an issue quite divorced from the law itself. It involved a presidential directive of last May concerning the replacement of 600,000 kilowatts of electricity to compensate for the power consumed by the AEC's plants in the Tennessee Valley area. The order

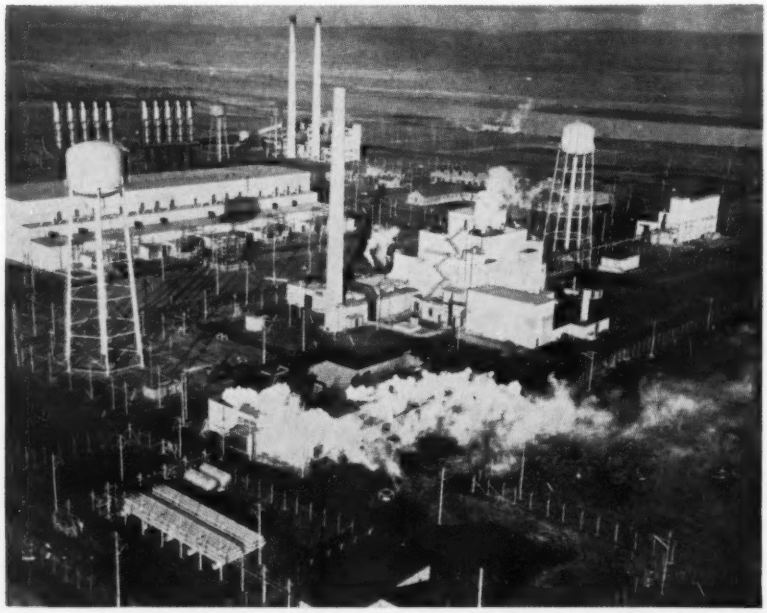
directed the AEC to buy the 600,000 kilowatts from a private power group consisting of Middle South Utilities (Dixon), and the Southern Company (Yates), the Commission then reselling this power to the TVA. The crux of the issue lies in the fact that proponents of the public power wish to see TVA expand its own facilities to provide the needed power, while the private power interests desire to open the way for private industry to supply it. The proposed Dixon-Yates plant would be built at West Memphis, Ark., while the proposed TVA installation would be erected at Fulton, Tenn. The antagonists of private power insist that the deal is a giveaway and that TVA could provide the power at a much lower cost than the private group can produce it.

The Fission Process

Any discussion of Atomic Energy Legislation naturally evokes interest in the theory of atomic energy, a knowledge of which is essential not only for a complete analysis of the value of the two laws, but for an understanding of the American program in that field, which is assuming mammoth proportions in the postwar arms race.

Comprehension of the word "fission" is the key to the understanding of the mechanics of the production of atomic energy. After the discovery of the neutron in 1932, experiments were carried out in 1934 to observe the effects of the bombardment of the atoms of the 92 known elements by these particles. It was found that rays emitted by radium, if aimed at a beryllium atom, would release neutrons from the beryllium nucleus: thus this combination formed a convenient source of neutrons. Most atoms, when exposed to neutron bombardment, absorb these particles in their nuclei to form heavier atoms, identifiable by their radiations.

Uranium, the heaviest, most complex atom to appear in nature, does not behave as the others when exposed to a stream of neutrons, as is shown in figure 1. Initially, the uranium nucleus snatches up the neutron, and U-238, the most abundant isotope of the metal, is transmuted to U-239. The new isotope is unstable, gives off electrons to form a man-made isotope of Neptunium, which, also unstable, "decomposes," to form another man-made isotope, plutonium.

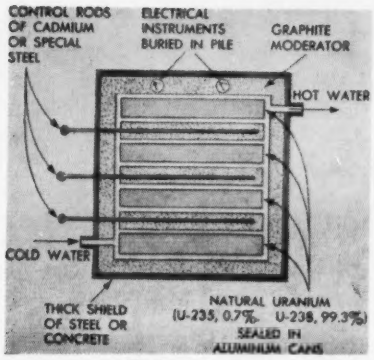


One of the main plutonium plants in the Hanford area at Richland, Washington.

The Plutonium isotope(Pu-239), exposed to neutrons, blows to pieces or fissions. It splits into two atoms of lower atomic weight, and simultaneously releases a large amount of energy. It is found that the sum of the weights of the two split halves adds up to a bit less than the weight of the original Plutonium atom; this difference appears as energy, or heat. Plutonium is not the only isotope which undergoes fission when subjected to neutron bombardment; a rare isotope of Uranium, U-235, which occurs in nature but 1/140 as frequently as U-238, of which uranium metal is principally composed, also is capable of nuclear fission. The principal problem of our atomic scientists during the first years of atomic energy development was the production of U-235 and Pu-239; these two substances comprise what the Congress has termed "fissionable materials" in its legislation.

Let us look into the uranium-235 or plutonium atoms and observe the fission process. The two halves of the split atom fly apart with speeds of about 10,000 miles/second, but inside the solid metal, can travel no more than 1/1000 inch; these fragments transmit their kinetic energy to other atoms, and this energy appears as heat. Splitting a U-235 or Pu-239 atom is one thing, but producing an explosion comparable to that of an atomic bomb is another. Actually, the fission of one such atom liberates no more heat than that supplied by a burning match. The nature of the fission process, however, makes it possible to set up a "chain reaction" whereby enough atoms are split within an infinitesimal time interval to produce the heat needed to destroy a city. Experiments show that when a U-235 atom fissions, 2.5 neutrons are shot from the split atom. This discovery is the keystone of the atomic bomb, for it uncovers the fact that fission provides a never-ending source of neutrons which could split every atom in a chunk of U-235 after the initial break-up of the first atom!

There are quite a few obstacles to be overcome before the fission theory can be put into practice in the form of an atomic bomb. The production of fissionable materials, that is U-235 and Pu-239, around which the greater part of the American atomic energy program has centered, has involved the most remarkable engineering achievements of our time. Let us divide


CONTROL RODS OF CADMIUM OR SPECIAL STEEL
ELECTRICAL INSTRUMENTS BURIED IN PILE
GRAPHITE MODERATOR
HOT WATER
COLD WATER
THICK SHIELD OF STEEL OR CONCRETE
NATURAL URANIUM (U-235, 0.7% U-238, 99.3%) SEALED IN ALUMINUM CANS

—*Westinghouse Electric Corporation*

Simplified schematic model of a plutonium pile.

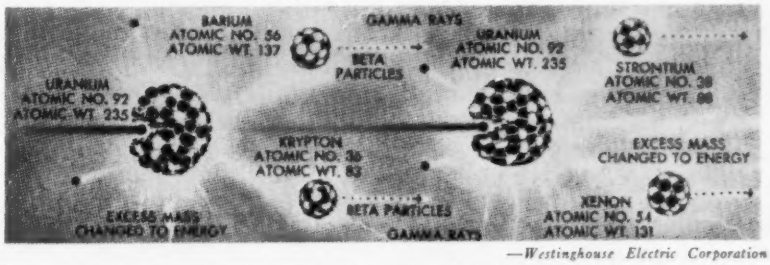
a sample of a fluoride of uranium obtained from the uranium ore, into 2 parts, from one of which is to be extracted Pu-239, from the other, U-235.

Plutonium Production

The production of Pu-239 is a transmutation process, that is, uranium must be transformed into a completely different substance through the medium of neutron bombardment explained above. Our sample goes to either of the mammoth plutonium plants at Hanford, Washington, or Savannah River, South Carolina, the first of which was built during the war by the DuPont Company and now operated by the General Electric Company under contract to the AEC and the second, erected just recently to produce not only plutonium, but tritium, and H-bomb material. The latter, the world's most expensive plant, cost American taxpayers over $1.4 billion.

Our nuclear transmutation process takes place in what is known as an "atomic pile", or "nuclear reactor", in which bars of uranium metal obtained from our fluoride sample, which contain both U-238 and U-235, are partially changed into plutonium metal. The bars must be exposed to neutrons, the source of which is the fission of the small fraction of the U-235 in the metal, which releases many more than enough of the precious particles to transmute its sister isotope. Consequently, the nuclear "fire" which occurs inside a reactor must be regulated to do away with the excess neutrons; cadmium control rods are inserted in the pile to absorb these. Loading a pile consists of inserting thousands of uranium bars into small holes which lead through thick concrete walls to the reactor core, where they rest in tubes surrounded by circulating water, a cooling medium necessary once the fire is started. Graphite moderators direct the neutrons to the U-238. The control rods are withdrawn to initiate the transmutation process, but can be reinserted to control the neutron flow.

After a several-month "cooking" period in the pile, the bars, which contain only a fraction of plutonium, must be cooled, that is freed of radioactivity for about a month. Plutonium, chemically different from uranium, can then be extracted from the bars through conventional chemical means. This, if collected into a "critical mass", constitutes an atomic bomb.


BARIUM ATOMIC NO. 56 ATOMIC WT. 137
GAMMA RAYS
BETA PARTICLES
URANIUM ATOMIC NO. 92 ATOMIC WT. 235
STRONTIUM ATOMIC NO. 38 ATOMIC WT. 88
URANIUM ATOMIC NO. 92 ATOMIC WT. 235
KRYPTON ATOMIC NO. 36 ATOMIC WT. 82
EXCESS MASS CHANGED TO ENERGY
BETA PARTICLES
XENON ATOMIC NO. 54 ATOMIC WT. 131
EXCESS MASS CHANGED TO ENERGY
GAMMA RAYS

—*Westinghouse Electric Corporation*

Shown here is the manner in which the fission of U-235 yields elements of lower atomic weight and energy.

Separation Of U-235

We shall now return to the remainder of the sample of uranium fluoride we left behind on our trip to Hanford. This is on its way to the huge U-235 plants at Oak Ridge, Tenn., Paducah, Ky., and Portsmouth, Ohio. Part of the Oak Ridge plant was erected in 1942 to produce U-235 for the first A-bombs, and the two latter were constructed by the AEC in its postwar expansion program. The Portsmouth Project is still in progress and will be completed in 1956 at a cost of $1.2 billions.

U-235, chemically identical with U-238, differs from it in only one respect; it is 3 units lighter. Thus the separation of the two isotopes raises a nearly insurmountable problem, especially since the one outnumbers the other by 140 to one in any given sample of uranium. The original method of segregation, known as electromagnetic separation, was employed to obtain the material for the first few A-bombs. The original plant at Oak Ridge, no longer in use, was built at a cost of $350 million to carry out this process. Uranium is combined with another substance to form a gas which is electrically charged and channelled past a giant magnet which deflects infinitesimally the lighter molecules, from which the U-235 is chemically separated.

The gaseous diffusion process has now replaced the above method in the manufacture of U-235. Gaseous uranium is directed through a series of barriers which contain tiny holes of the order of one ten-millionth of an inch in diameter. The lighter U-235 molecules travel through these openings slightly faster than the heavier U-238 particles. The gas which emerges from each barrier is ever so slighty richer in U-235 content than when it entered the barrier; however, the gas is enriched by only one part in 1000 upon emerging from one barrier, so that the gas must be passed through thousands of barriers before the U-235 molecules are segregated. For this reason, the Oak Ridge installation is the world's largest continuous process plant; it consumes more electricity in one day's operation than New York City to operate the pumps which propel the gaseous uranium in its month-long path through the multitude of barriers, and uses more water daily than does the city of Washington to control the gas's temperature.

An interesting sideline of the gaseous diffusion process lies in the development of a new line of materials, fluorcarbons, which were essential to the success of the operation. It was found that the only gas suitable for gaseous diffusion was UF_6, uranium hexfluoride, as

(Continued on page 47)

Problems in Helicopter Design - II

by ARTHUR VAUGHAN, EP '57

Success in vertical flight was achieved after workable rotors were invented and efficient power was available. These topics, considered in Part I, are still fundamental.

Along with forthcoming high-speed, high-lift, long-range, or otherwise un-orthodox forms of rotary wing aircraft, new problems, many of them unfamiliar, are encountered. These are associated with fuselage shape, control and power systems, and rotor configuration. It is intended in this article to present some of the more important examples of advanced and projected designs as reported by helicopter manufacturers and research organizations, and to refer to specific research goals, and to the economic aspects of helicopter engineering.

Distribution of Research

Up to the present, almost all of the helicopters in this country have been produced by five companies. All the advanced helicopters being produced today seem to be headed for military rather than civilian use. Until the third quarter of 1953, the total number of helicopters which had been produced was less than 3000.

The biggest government contracts for any one aircraft are for the Sikorsky S-56, twin-engine ship, totalling about $100 million. Convertiplanes (airplanes which may convert to vertical flight while airborne, by means of an adaptable rotary wing) are being developed under government contract by three U.S. aircraft companies. The Army Transportation Corps, in 1954, contracted for some $150 million in helicopters, and expects to buy $1 to $2 billion in helicopters in the next five years.

The armed forces altogether are responsible for about 50 per cent of the helicopter projects being carried on under NACA sponsorship, and are concerned largely with designs for special military applications.

Rotor Configurations

A discussion of rotor configurations may be organized into five parts: (1) Single rotor with counter-torque tail rotor, for small ships, under 6000 pounds; (2) lateral-dual systems, weight greater than 5000 pounds; (3) tandom rotors, large helicopters; (4) Syncropter-type helicopters; and (5) co-axial systems. These configurations are sketched in figure 3.

In single-rotor helicopters, pioneered by Sikorsky, only a small torque correction is required; and because transmission and control system complications are at a minimum, such ships are the most economical to build. They have good maneuverability, but are somewhat wasteful of power due to the tail rotor. The tail rotor produces some tendency to "weathercock" in a tail wind, and is in danger of being struck by objects near the ground. These difficulties, together with the need for close control over the center of gravity, limit the range of application of single-rotor aircraft, but do not prevent its being a highly capable machine for use in mail carrying, rescue work, and other civilian uses. The Sikorsky XH-39, which holds the speed record, is this type (and is also the first helicopter to employ retractable landing structure).

The first truly successful helicopter, developed by Heinrich Foche, Germany, 1937, was the lateral-

Fig. 1 The Hiller YHJ, believed to incorporate principles that will be widely adopted for both large and small future helicopters, uses tip power that eliminates conventional power-plant systems.

—Hiller Helicopters

dual type, which has the advantage of utilizing full rotor power for lift. The winglike pylons contribute to lift in forward motion, thus unloading the rotors.

This type, in addition, has a short fuselage, and the pilot may maintain high lateral control. The difficulties experienced with the lateral design concern its complex transmission, the need for syncronizing the rotors if they overlap, high structural weight (reduced payload), and a high frontal "equivalent flat plate" area.

(The general problem of reducing parasite drag has not until recently been given as much engineering consideration as it merits for the simple reason that a majority of efforts have been spent in making the helicopter fly properly. In the newer ships care is taken to improve the shape, to provide smoother flow over protuberances, and to fillet such objects as the hub, rotor mast, landing gear, etc. In forward flight, the fuselage inclines toward the flight path, which increases the frontal area, and, in high speed flight, introduces complex control and stability problems associated with the fuselage.)

It appears that a somewhat blunt afterbody may be more desirable from the standpoint of directional stability than a smoothly faired afterbody.

Nearly all presently considered large passenger-carrying helicopters are, and probably will be, of the tandom type. The pioneers in this design are the Piasecki Helicopter Corporation, who build the familiar "Flying Bananna" and similar models. These helicopters, having excellent structural properties, are promising, due to a small frontal area, good longitudinal stability (they have only fair lateral stability), a short span, and a noncritical center of gravity. Unavoidably, tandom machines must have a complex transmission including syncronizing mechanism, and they require expert pilots.

The fourth configuration to mention is the relatively new "syncropter" type, introduced successfully in 1939 by Aston Flettner. Having intermeshing rotors requiring syncronization (whereby gear failure would be dangerous), syncropter ships possess remarkably good maneuvering and control characteristics which make them a promising design for all-round use. Due to the tilted rotor axes, ground clearance at blade tips is limited, and blade solidity (the ratio: blade area disc area) is limited by the clearance required between hubs. This type has the highest transmission efficiency (the ratio: power supplied to rotor/available power) of any current helicopter types: roughly 87%.

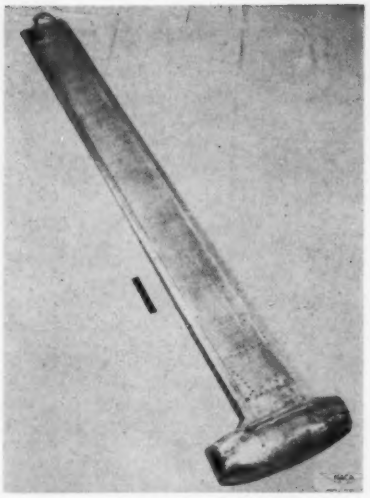


Fig. 2. Ramjet engine-blade combination, early model, used for tests of thrust, drag, and fuel-feed characteristics.

—NACA

The design employing superimposed or co-axial rotors, pioneered in the U.S. by Stanley Hiller, 1943, deserves attention, this type claiming excellent maneuvering and lift performance. The rotors need not be syncronized, a great advantage. However, many fundamental troubles are present in co-axial systems. They have a complex control system, excessive overall height because of clearance required by flapping blades, and in addition suffer from instability about all axes. Aerodynamic interference occurs in the downwash of the superimposed blades. These shortcomings need to be ironed out.

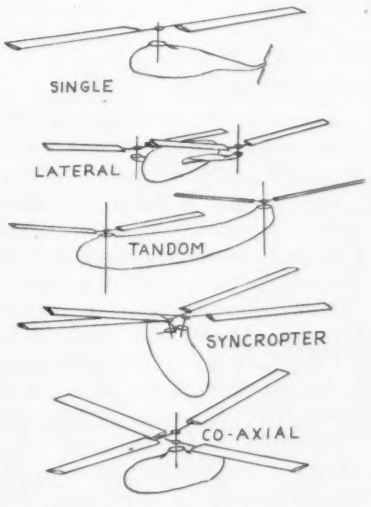


Fig. 3. Sketch indicating the five helicopter rotor configurations.

Jet-Powered Systems

Helicopter drives are run for a considerable part of their operative lives at a very high percentage of their rated torques (as compared with automobile drives, which run most of the time at about 25% rated torque).

With the need for weight-saving this results in the use of very highly loaded gear teeth, whereby wear problems constantly arise. Because it is difficult to maintain an adequate oil film between moving parts the wear problem is accentuated and overheating of oil difficult to avoid.

Reaction engines have long been considered an advantageous source of power for helicopter lifting rotors, since all anti-torque and transmission needs are eliminated, resulting in greater simplicity and less weight. The ramjet, or "Athodyd", was recently introduced in an experimental design, and has since been shown likely of success.

Commensurate, at present, with the ramjet's advantages over piston-engine-powered lifting rotors are troubles brought about by high inertial forces (on the order of 1500 G) and high aerodynamic drag, at the blade tips, where the engines are located. In order to supply fuel to the units it is necessary to pipe the fuel out along the rotating blades, and, under the circumstances of varying rotor rpm, control of the fuel supply becomes quite difficult. The G force distorts the fuel spray pattern, and produces a high rate of fuel consumption. Thus ramjet helicopters have a low efficiency of propulsion and a short range.

In autotation, which would occur following an engine failure, the

drag of inoperative jet units is likely to result in excessive descent rates in present models.

The jet helicopter loses roughly 5% of its maximum power while hovering, due to heating of the air by preceeding engines. This circumstance is no problem however, and in forward flight is absent. Smoke trails follow down the slipstream and do not contaminate the tip path. There are many thermodynamic problems yet to be solved related to ramjet helicopters, and they are receiving much attention. It should be noted that in spite of inefficient propulsion, and because of the increased payload due to the lack of piston engines and transmission, the ramjet helicopter is economical to operate, over short ranges.

While it appears unlikely that the ram-jet characteristics will be much improved, the "self-aspirating or wave type of pulsejet" offers some promise, although extensive development will need to be done before this type is adequate for service.

Turbine power

Another application of the non-piston engine to helicopters is in the Sikorsky XH-39 already mentioned, which has a turbine-propelled lifting rotor. Still another, the Hughes XH-17, an extremely large high-lift helicopter, is designed to transport heavy military equipment over short distances, and employs two jet engines fixed to the sides of the fuselage. The gas pressure developed by these units is piped to thrust outlets at the blade tips. The rotor is 136 feet in diameter. Long legs of this "Flying Crane" are designed to straddle the cargo to which the helicopter is attached.

At the opposite extreme in size, figure 1 displays a tip jet-powered two-man machine, developed for military evaluation, and it represets the most recent development of the Hiller Helicopter Corporation. The craft has an empty weight of 500 pounds, and is unusually simple both in design and performance. It has a two-blade see-saw rotor, and can lift more than its own weight in payload. It is expected to be the first jet-powered aircraft of any type to receive CAA certification in the United States, and to have proved the feasibility of this form of power supply for helicopters. The model is not scheduled for production, nor are there plans for marketing it commercially.

Fig. 4. The Sikorsky S-55, largest helicopter now being used for commercial transport, carries eight passengers.

—Cornell Aeronautical Laboratory

In all existing multirotor configurations, work remains for a thorough investigation of the aerodynamic characteristics of the rotor blades in the various arrangements. Helicopter flying qualities continue to be an important matter. Advanced configurations require study especially, for example, of induced velocities in the tandom rotor, wherein induced power loss is an important unknown.

Disc Loading

The term loading refers to the relation between gross weight and rotor disc area. Low disc loading (about 2 to 2.5 lb/sq. ft.) gives good maneuverability and fairly high cruising speeds. Average loads (about 2.5 to 3 lb/sq. ft.) are intended for all-round performance. Theoretically, high disc loads (3 to 3.5 lb/sq. ft.) result in higher payloads, but speed is restricted due to premature stalling at blade tips.

In an effort to keep down size, values of disc loading of 8 to 10 psi are being used in prototypes now flying. To achieve high speed, both the solidity ratio and the number of blades must be increased, the former to retard the effects of high rotor rpm and the latter to reduce the level of vibration.

The danger of power failure and excessive descent rates for highly loaded rotors will probably necessitate the use of more than one engine on future large passenger-carrying helicopters.

Conclusion

The major problems confronting the rotary-wing industry today are mostly related to the complex loading on the main rotor systems, the complicated mechanisms of these systems, and their controls.

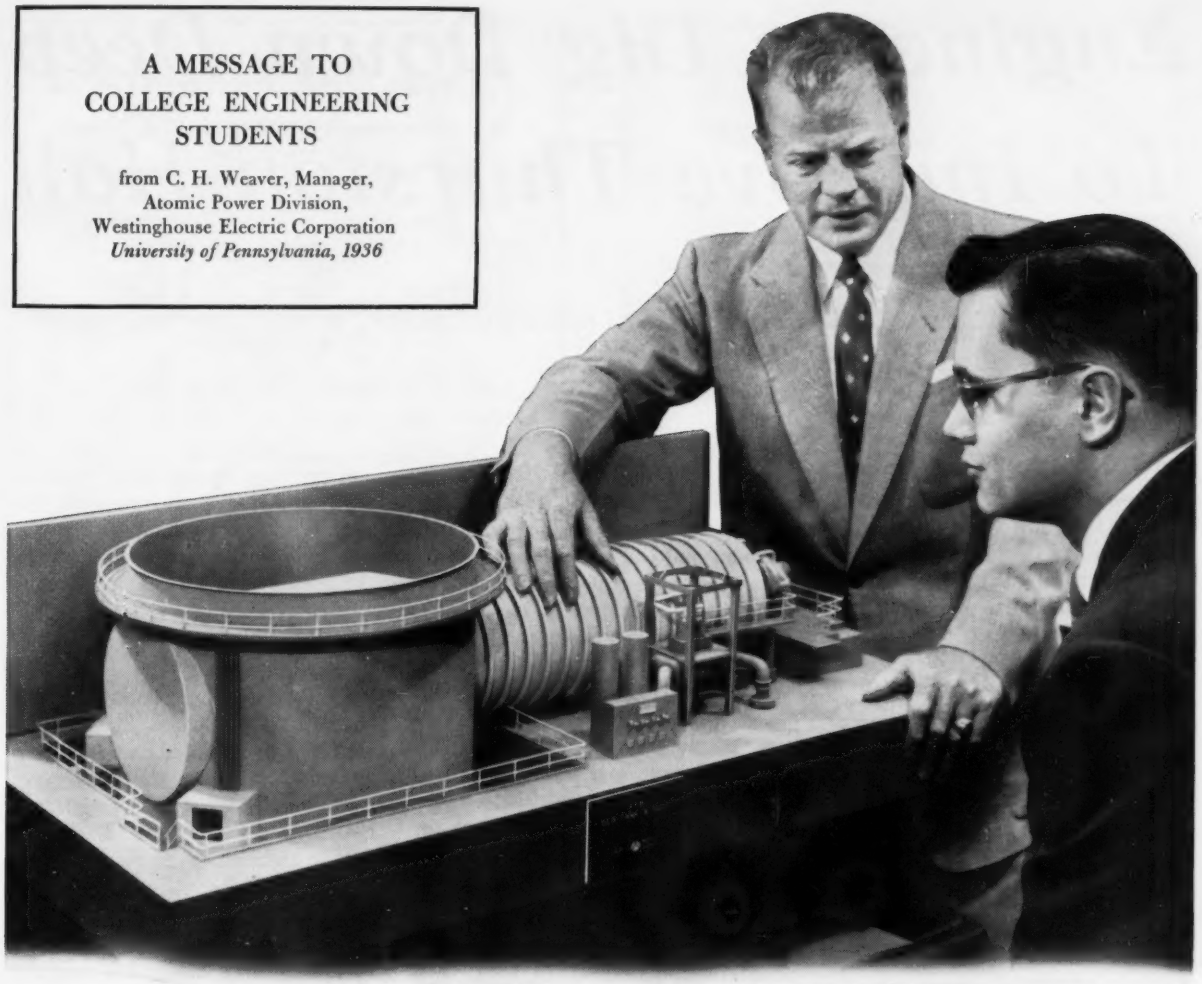
The outstanding difficulty is that of designing for adequate fatigue life. Present methods of predicting airloads are unconservative, by a factor of 3:1 in transition (from hovering to cruise) and landing flight conditons. As a result, the development of an acceptable rotor system is likely to take considerably longer than the rest of the airframe: three to four years.

The present helicopter is an expensive vehicle, the least expensive model having a selling price of about $35,000.00, far more than one might expect. Manufacturers believe that as more is learned this price will drop to perhaps $4000.00,

(Continued on page 37)

A MESSAGE TO
COLLEGE ENGINEERING
STUDENTS

from C. H. Weaver, Manager,
Atomic Power Division,
Westinghouse Electric Corporation
University of Pennsylvania, 1936



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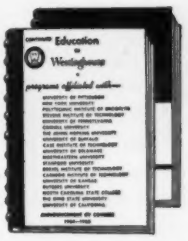

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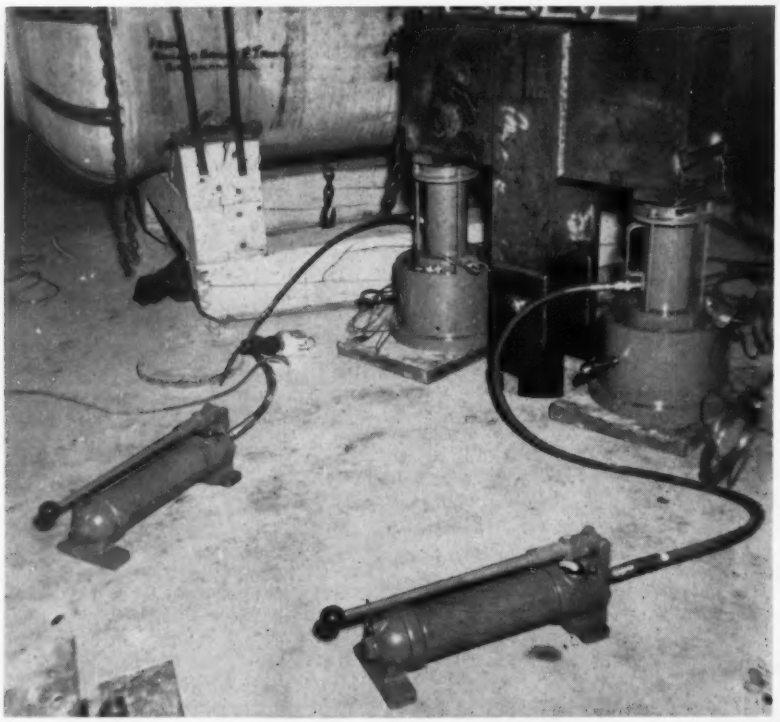
Engineers Dig Down Deep To Improve Thurston Hall

by RICHARD BRANDENBURG, EP '58

Twenty-seven alloy steel rods mounted in bedrock will provide improved testing versatility in the Thurston Hall materials testing bay. The rods will be used as supports for full size structures as they are subjected to tensions and compressions to gage structural reliability under conditions of actual use. The technique of applying loads against anchored rods for large scale testing is being attempted for the first time in the Thurston Hall project.

The testing bay itself is of special construction, designed to take loads from any direction. The large steel beams in the walls and ceilings and the eighteen-inch thick concrete floor can support jacks that apply pressures to a structure from its top, bottom, and sides. Several foundation walls run from the floor slab to bedrock. A ten-ton overhead crane is located on tracks on the ceiling, allowing it to move the length and width of the bay. With these facilities full size components can be studied, making small model testing unnecessary.



New tests supports in use allow structure to be loaded from the floor by jacks, thus increasing the versatility of the testing bay.

—Steve Beck

A rectangular pattern of twenty-seven vertical rods mounted beneath the floor will provide operational flexibility when the work on the new supports is completed. Since the rods will not be located at equal distances from each other, they will enable a variety of structural shapes to be studied under varied load conditions. Each of the rods will be mounted in a hole that is thirty feet deep. An average of twenty-five feet of the length will be within bedrock itself. Each hole will be eight inches in diameter and designed to receive one of the half-ton, three-and-one-half-inch diameter rods. The bottom eight feet of the length of each rod is made up of a series of ears or flanges to insure effective bonding when the cement is poured.

A non-shrinking cement called "grout", patented by the Intrusion Prepakt Corp., the firm handling the overall drilling operation, will be forced under pressure around each rod. The cement will flow into crevices in the rock, forming a firm bond between the rock and the rod itself. The non-shrinking properties of the cement prevent cracks and splitting after setting. Actually, the cement used expands as it sets to insure firm support. After grout has been placed between the rod and rock under pressure, unpressurized grout is added to fill up the remaining space. A covering is placed over the upper part of each rod to prevent undesirable bonding at the top of the rod between the steel and the cement. This precaution eliminates bond failure due to stretching that would normally occur when rods are in use.

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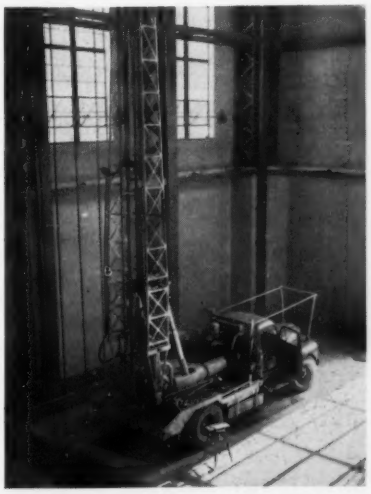
The top of each rod is threaded to receive a coupling made of steel alloy. Any part of a structure to be tested can be bolted on the coupling or can be held in place by pinning or welding. One type of test setup would involve pinning a beam at each end, and loading it by means of hydraulic jacks placed between the beam and the floor. Each hole and rod unit is designed to take a direct upward pull of 200,000 pounds.

According to Professor F. O. Slate, of the Engineering Mechanics and Materials department, work on the new supports will be completed within two or three months. He pointed out that one month is required for the cement to properly harden. Work on the new testing mechanism started in mid-September. The facilities will be used for teaching purposes, University research, and sponsored research projects with industry.

Complementing Thurston Hall's improved full-scale testing equipment are a variety of other test devices located in the testing bay. There is a 300,000 pound universal testing machine that can create both tension and compression on a work piece. In addition there are a 400,000 pound and a 100,000 pound testing machine in the bay. Loads are indicated on gauges reading pressure changes in oil lines connected to the pistons of the testing machines.



Drilling rig used to drill holes in the floor of Thurston Hall testing bay.
—Rod Glover

Other equipment includes a fatigue testing machine that has been used to test hull plates of liberty ships by subjecting them to a flexing action between the machine's movable jaws. A freezer is available to enable freezing and thawing tests of concrete and stone to be made at temperatures as low as -20°F. An X-ray room adjacent to the testing bay is used to study imperfections in metal structure, and a concrete laboratory provides facilities for research and instruction in the use of concrete.

The Thurston Hall improvements are an important factor in conforming the test bay to modern structure testing trends. The new philosophy is that of creating test machines suited to the job to be done, rather than modifying a particular structure to meet existing test machine limitations. The vertical supports now being installed in the test bay floor complete the test-box character of the entire laboratory. Loads in combination can be applied from any direction, limiting the application of the test bay only to the ingenuity of its users.

TECHNICAL EDUCATION-EUROPEAN STYLE

The following is a comparison between the technical schools of Europe and those of the United States, typified by Cornell, as seen by Dr. Henri S. Sack. Dr. Sack is a member of the Department of Engineering Physics at Cornell, teaching solid state physics and related subjects as a full professor. He came to the University fourteen years ago from the Federal Institute of Technology in Zurich, Switzerland, where he did both his undergraduate and graduate work. The reader should bear in mind that any comparisons are with the Europe of fourteen years ago.

The essential differences between the technical educational systems of Europe and America are a result of differences in the high school systems. The average American high school graduate is not very well prepared for college, much less for a technical school, due to the lack of a technical background. (Exceptions are graduates of technical high schools, which are comparatively rare.) He has not yet learned that the responsibility for a worthwhile education is his and not that of his teachers. Likewise, he usually is not adapted to the lecture system, the backbone of most college courses. In Europe, and more particularly in Germany and Switzerland, the student decides on the general orientation of his profession when he enters high school. Thus there are specialized high schools able to devote their entire curriculums to giving the student a good background in that material which will be basic to him in college. The last year of high school has a university atmosphere; many courses are given under the lecture system, and the student begins to learn the art of note-taking; responsibility for effort lies largely with the student, though there still is required work. Competition is more intense than in the United States, for the poor students have already been transferred to another type of high school. Consequently, the European student does not have to undergo the big transition between high school and college that the American does.

The European student is more mature and more carefully groomed for the academic life due to these geared high schools.

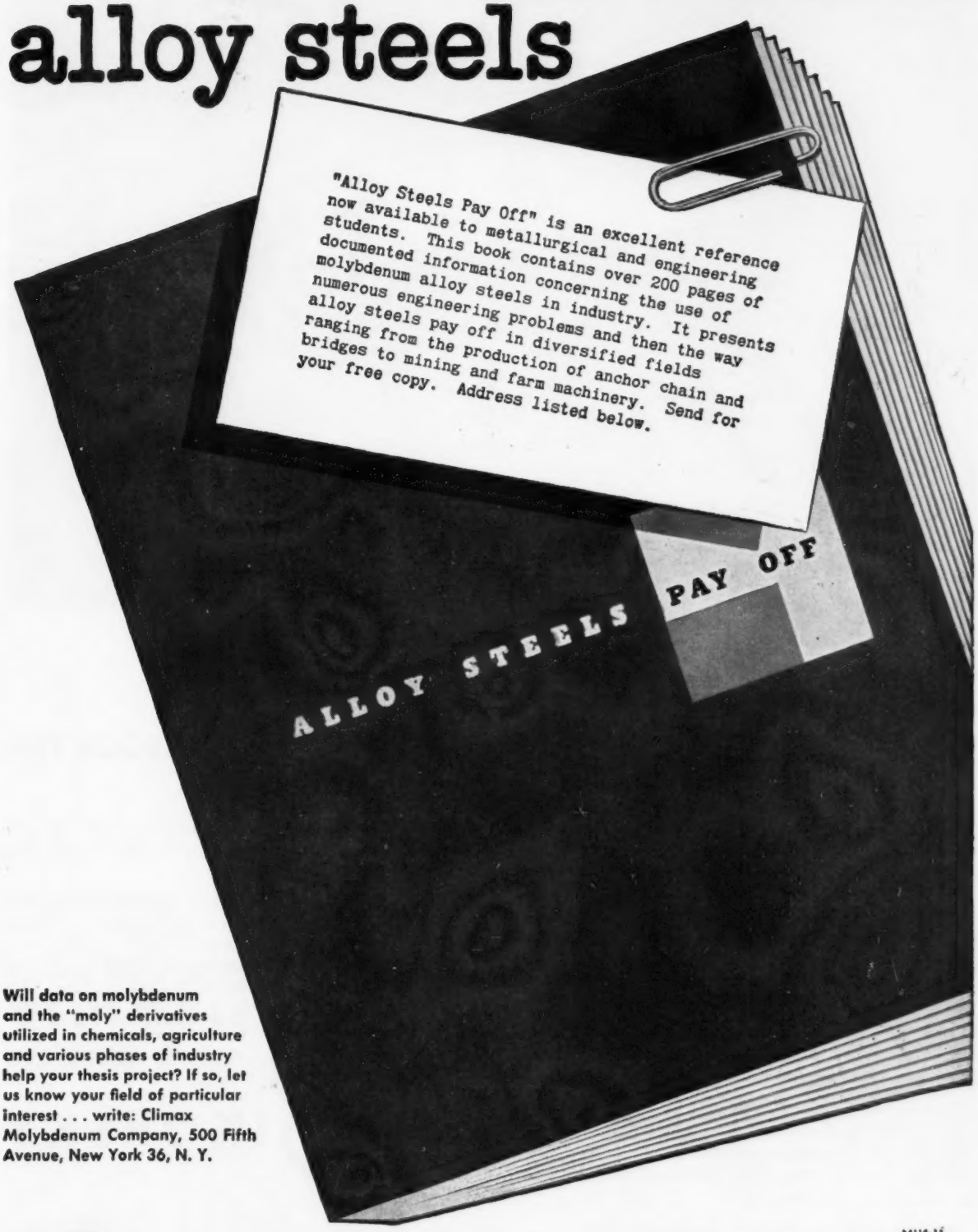
A wide difference in examining methods are found between the continents. There are no final exams, prelims, or quizzes, as we have here. In Dr. Sack's field, physics and math, comprehensive exams in each subject were given at the end of two and four years, a number not uniform for all courses. A further difference between the two educational systems lies in the course content. In Dr. Sack's opinion, the student at Zurich may possibly have more knowledge at the end of his four years than the student here, due not to more courses, but rather to the approach used there. Subjects are covered more thoroughly; emphasis is more on basic principles than on applications, which are emphasized here. Also, the student does much more work on his own. Of course, science has made great advancements since the period of which Dr. Sack speaks. It should also be realized that the market for engineers is different in Europe than in America. There, engineers do very little drafting or other routine; they do work that can only be done by those educated at the university. The routine is done by technicians coming from different schools.

The casualty rate at the Federal Institute was possibly 20-25%, due probably to students reaching the peak of their development before going very far through college. Because they develop no further, these drop out. In this country the problem is more serious, as selection is complicated by the high school enigma. The American high school graduate is primarily an unknown quantity whose capabilities for college and technical work can be little more than guessed at by admissions committees.

Professor H. Sack

When Dr. Sack same to this American university he was somewhat uncertain. However, he now likes this life very much. He believes that the greatest asset of our educational system is the greater contact found between students and teachers. In Germany and Switzerland, contacts are less intimate. It is difficult for a student to talk to a professor, for there a professor is a "big shot" and a student is a "very, very little man." The Doctor enjoys life here and doubts that he would want to return to Switzerland.

60 case histories of alloy steels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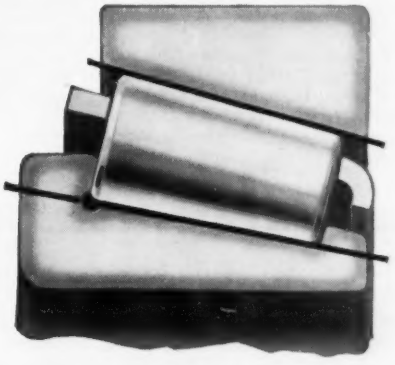

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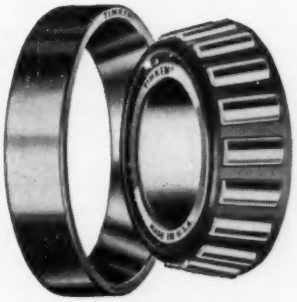

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"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates, and former students and to establish closer relationship between the college and the alumni."

YOUR SOCIETY

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates, and former students and to establish closer relationship between the college and the alumni."

These are worthy objectives and if accomplished provide a real service to your college and to all its alumni. Your Society guided by these objectives has worked hard for many years trying to fulfill them. We feel that we have been fairly successful in this but at the same time we know we can do a lot better job if we have a larger membership.

We have averaged about 3,000 members with a small variation above and below this number for quite a few years. There are, however, about 18,000 living engineering alumni and only one sixth of these as members of the Society is not too good a record. We have decided this year to make a concerted effort to increase this membership.

Our active chapters, and there are a number of these doing a very fine job, are attracting new membership. They provide Cornell engineers in a given area with an oppotunity to meet with their fellow graduates a few times a year to renew old acquaintances and make new and useful contacts.

We are also this year for the first time publishing a directory of the names and business connections of all the members of the Society. This directory should prove very useful to the members in that they will be able to find out who is located in a city or local area in which they may wish to make a business or social contact. It is planned to have this directory go to press about February first and the name of anyone subscribing to membership before that time will be included. The subscription for membership is only $3.00 a year and also entitles the member to a year's subscription to this magazine.

If every existing member of the Society would try and get at least one new member a worth while increase in membership would result. The Executive Committee of your Society earnestly urges you to try to do this. It should not be too difficult to find at least one Cornell engineer of your acquaintance who is not a member and persuade him to join. A letter containg name, class, mailing address, firm name and position in the firm with $3.00 sent to the Society's headquarters at 107 East 48th Street, New York 17, New York, is all that is required to enroll a new member.

ALUMNI ENGINEERS

Robert C. Dennett, C.E. '04 engineering consultant of the National Board of Fire Underwriters, was honored September 30, at a dinner in the Hotel Commodore, New York City, marking his retirement after fifty years of continuous service. Mr. Dennett was a field engineer with the National Board for fifteen years, office engineer for twenty-five years, and assistant chief engineer for ten years. During World War II, he was advisory engineer in charge of fire protection for the Navy's Bureau of Yards & Docks. Dennett's present address is 155 North Columbus Avenue, Freeport. He plans to live in Wayne, Me., next spring.

Carroll R. Harding C.E. '10 received an honorary degree from Hobart & William Smith Colleges at Geneva, June 13 last. To quote from the citation: "Civil engineer, executive, and churchman. Born in Maine, graduated from Cornell, he has spent a life-time applying his knowledge and skill to the improvement of railway transportation. . . . Designer and builder of bridges, watchful maintainer of the highest standards of railroad construction and maintenance, he is one of those responsible for the rapid development of our West and Southwest in this century. . . . Son of an Episcopal priest, he has himself been a devoted layman, serving well both his own parish, St. Chryostom's, and the diocese of Chicago. We honor him today as one who has strengthened the sinews of America and are proud to admit him to the ranks of our honorary alumni."

Ralph Brown E.E. '13 is vice president of Bell Telephone Laboratories, 463 West St., New York City. He is in charge of long-range planning of the Laboratories programs. He has been with the Bell System nearly thirty-five years, much of the time in charge of research, specializing in radio broadcasting, ship-to-shore and overseas telephony, and radar. He was awarded the Morris Liebmann Memorial Prize by the Institute of Radio Engineeers in 1926, and in 1949 received the Institute's annual Medal of Honor. He served as president of the Institute in 1927.

H. B. Peters, C.E. '15, has been appointed chief engineer, refining department, of the Texas Co. He joined the Company as a draftsman in 1925 at their Port Arthur, Texas refinery and succeeded to several refining engineering assignments. He was named assistant chief engineer in 1937.

W. Griffin King M.E. '17 retired in April, 1953 as secretary of Case Institute of Technology and has spent most of the time since in visiting Mexico and Europe. Mr King's address is Metcalf Road, Willoughby, Ohio.

James C. Travilla M.E. '22 6940 Columbia Avenue, University City 5, Mo., is vice-president in charge of engineering, General Steel Castings Corp., Granite City, Ill. "Most

Ralph Brown

Will Rowand

of this year," he writes, "has been spent in South Africa, Mozambique, and in Europe on business."

Laurance H. Daniel E.E. '24 was born in Havana, Cuba and now lives there at Baratillo 9. He is president of Laurance H. Daniel, Inc., and acts as a consultant for various insurance companies. He is a director of the Havana Yacht Club, and secretary of the Cuban Section of the American Water Works Association. Mr. Daniel is vice-president of the Cornell Club of Cuba.

Koachiro Shimizu C.E. '24 is president of Yokohama Engineering Works Ltd., Yokohama, Japan. His son, **Nagakazu,** who is employed in the Ithaca factory of National Cash Register Co., received the Master's Degree in ME at Cornell in '53. Mr. Shimizu is a member of the Cornell Club in Tokoyo. He is a grandfather; his daughter, Hiroko, has two children. His address is No. 294, Kakinoki-zaka, Meguro-ku, Tokoyo, Japan.

Haig K. Shiroyan E.E. '24 is assistant engineer with Consolidated Edison Co. in New York City. He is a trustee of Queens Public Library, president of the board of deacons of the First Congregational Church of Flushing, president of the United Men's Clubs of Flushing, and vice-president of the Interfaith Society. He is secretary of the Cornell Alumni Association of New York City. Mr. Shiroyan has published a novel entitled **The Green Bride.** He has three children, **Richard,** who is at-

tending Cornell, Louella, and Lenore.

Robert R. Bridgman M.E. '25 is a design engineer with K. R. Wilson Co., Arcade. His address is 190 South Creek Road, RFD 4, Hamburg, N. Y.

Will H. Rowland M.E. '29 vice-president of Babcock & Wilcox Co. of New York, was awarded the Newcomen Medal for achievement in the field of steam, at a joint meeting of the Newcomen Society and The Franklin Institute in Philadelphia, Pa., January 18. The medal, which is awarded by the Society not more than once every three years, was presented to Rowland for his many contributions to steam progress, among which was his invention in 1936 of the cyclone steam separator. His address is 38 Slope Drive, Short Hills, N. J.

Ralph L. Hill, Jr. M.E. '31 is a sales engineer with Washington Refrigeration Co., Washington, D.C. He resides at 6208 Greentree Road, Bethesda, Md.

Robert M. Scott C.E. '32 is a project engineer with Campbell Soup Co., Camden, N.J. His address is 7148 Crittenden Street, Philadelphia, Pa.

Edward E. Lipinski C.E. '33 has organized Lee Foundation Co., foundation and concrete contsruction firm, Baltimore, Md. He lives at 2815 Onyx Road in that city.

Charles M. Ham A.E.'36 has been promoted to engineering section head for radar production in the surface armament radar engineering department of Sperry Gyroscope Co., Great Neck. His address is 200 Harvard Street, Westbury.

National Advisory Committee for Aeronautics has announced the reappointment of **Robert B. Roe E.E. '39** to its subcommitte on helicopters. Mr. Roe is head of the flight operations engineering department of Sperry Gyroscope Co., Great Neck. His address is Box 571, Stony Brook.

Jerrier A. Haddad, E.E. '45 joined IBM in 1945 in the technical research department. He has been with IBM ever since and in 1952 was made manager of component development. In 1953, he was promoted to manager of the Endicott Laboratory and has just been named director of advanced machine development. He is married to Margaret Van Hamlin '45 and lives in Fishkill.

Calvin G. Brown C.E. '45 is a hydraulic design engineer with the water department of the City of San Diego, Cal., where he lives at 2345 Balsa Street.

Victor Beecher, C.E. '47 has been elected vice-president of Berman Construction Co. of Flushing. His address is 1225 Ocean Parkway, Brooklyn.

Raymond H. Schumacher, Ch.E. '48 111 Cleveland Avenue, Milford, Ohio, has been promoted to cost engineer at the Ivorydale, Ohio, factory of Procter & Gamble Co. He joined P & G in 1948 and was named supervisor of the Ivorydale kettle house and hydrolyzer departments in 1951. Mr. Schumacher is married and has two children.

Max H. Kraus E.E. '49 8315 Brookside Road, Elkins Park 17, Pa., has been appointed manager of National Jerrold Systems, Inc., a Philadelphia company specializing in television distribution systems.

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For more than 70 years CRESCENT Wires & Cables have played a leading role in the growth of the electrical industry. Pictured here are just a few of the many wires and cables made by CRESCENT.

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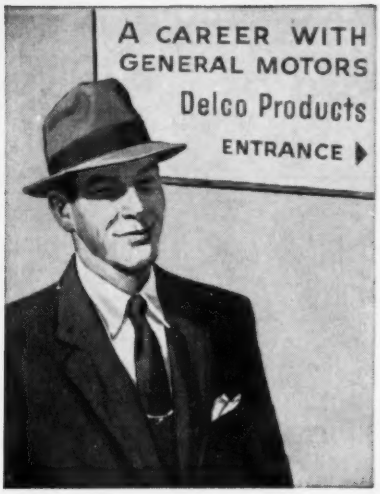
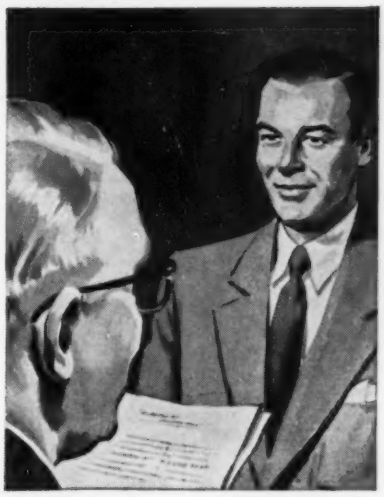
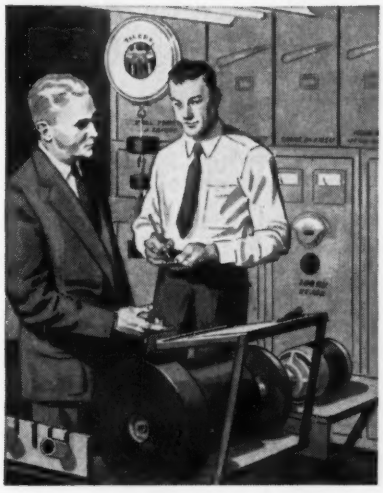
Here's what happens when you take a job with DELCO PRODUCTS



1 When you take a job with Delco Products, you start a career with General Motors—with a division known throughout the world as a leading manufacturer of electric motors, hydraulic shock absorbers, and many other products.



2 You enter into a well-organized training program—a program specifically designed to take full advantage of your particular interests and abilities. You don't just "go back to school." Instead, you *learn* by *doing*, with top-flight supervision.



3 As a trainee you get into every conceivable phase of Delco's engineering operations — engineering laboratory, plant engineering, drafting, sales, processing, standards, quality control. Additional assignments are often made in related departments for broader experience.

4 Training completed, you'll be given a specific departmental assignment. Progress can be made in product development, technical staff operations, sales, or in manufacturing supervision—according to your interests and capacity for future development.

5 With Delco's policy of promotion from within, your opportunities for advancement are virtually unlimited. Not every trainee becomes a supervisor, but some go much farther. Many General Motors top executives today are "graduates" of Delco Products Division.

If this opportunity interests you, sign up for the GM interview on your campus and ask for referral to Delco Products. For booklet detailing Delco's engineering activities, write to:

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Delco Products Division, GMC
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College News

Cornell Aero Lab Shows Increase in Backlog of Contracts

The Board of Directors of Cornell Aeronautical Laboratory, Inc. has heard that the Laboratory's backlog of contracts reached $12,350,000 on Dec. 31.

Contracts Manager John J. O'Neil told a semiannual meeting of the board that new figure is an increase of $1,975,000 over the previous year's backlog of $10,375,000. He said the increase marks a reversal in the trend of the contract backlog.

Detailing the financial picture, Mr. O'Neil said the Laboratory's backlog of research contracts Oct. 31 was $8,200,000, a decline of $3,000,000 from the same period last year. However, he said the decline is explained by a later than usual annual negotiation of a large contract budget.

$4,900,000 in additions to existing contracts, mostly work in guided missiles and tactical air support for ground operations, was predicted for the period from October to December. In addition, $1,000,000 in contracts was predicted for work on stability and control of aircraft, high speed aerodynamics, electronics, and wind tunnel testing.

"The Laboratory may look to the future with optimism," he said. "The annual government budget for defense research and development will apparently continue at a level of $1,200,000,000 for the next several years and the Laboratory's part in the national defense picture will continue to be supported by a contract structure emanating from those funds."

He reported the Laboratory's gross volume of business in fiscal 1955 will amount to at least $10,500,000, an increase of $500,000 over fiscal 1954.

Excellent technical results have been achieved within the last several months on large programs in important defense areas, Mr. O'Neil said. The 12-foot variable density wind tunnel, which broke an all-time operating record of 400 hours in October, has its highest backlog in history — $3,200,000.

"A major share of private wind tunnel testing in behalf of the government in fiscal 1954 was accomplished in the C.A.L. tunnel," he continued.

As contrasted to the large-scale programs of Laboratory-wide effort, he reported, "the less spectacular, single-type research effort conducted within individual departments is nevertheless very important in terms of significant contributions, and is expected to continue at roughly one-half of the Laboratory total."

Mr. O'Neil said the Laboratory's industrial program, which represented only about two percent of the total effort in fiscal 1954, will probably achieve a modest increase.

Changes at Olin Hall

Professor Von Berg, who had been on leave for the past year and had been employed as chemical engineer by the Dow Chemical Co., is at Cornell again. However, one of his colleagues has taken leave this year.

Professor Gregg is employed as metallurgical engineer at the Oak Ridge National Laboratory.

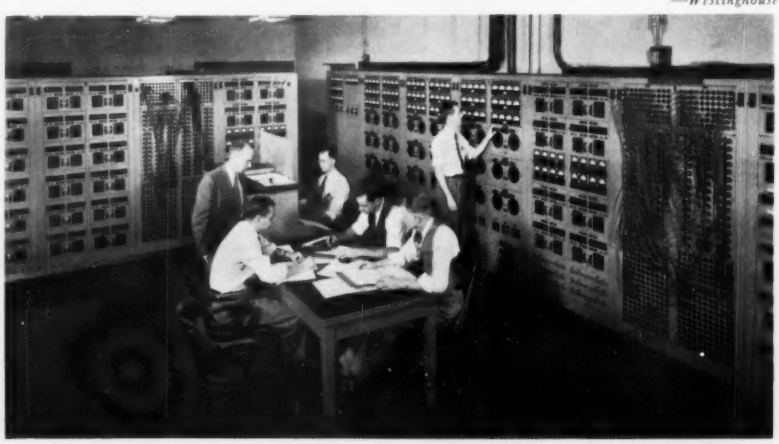
New Vet School Praised

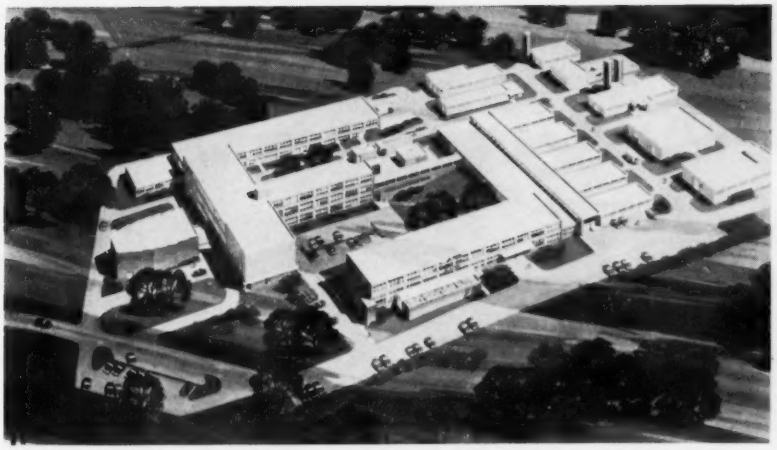
National recognition is given to the new $5.5 million Veterinary College building program at Cornell University by Architectural Forum, leading architectural and construction industry magazine.

"Long famous for its research and pioneering of new techniques," says the magazine, the school "will now undoubtedly become an inter-

Shown in use here is about half the equipment that will comprise Cornell's new Westinghouse network calculator.

—Westinghouse





Artist's conception of the New Yeterinary school, now under construction.

national pilgrimage stop for study of its physical plant."

According to the Forum, the new Cornell facilities designed by architects Isadore & Zachary Rosenfield of New York City are a "truly integrated plant," whereas most institutions of this type usually are planned in only haphazard fashion "to the old concept of these institutions — a self-contained classroom and research building convenient to a random collection of barns."

Arch. College to Have Visiting Critics

The College of Architecture at Cornell University has announced the appointment of five visiting critics and a visiting artist for the current year.

Edward Millman, visiting artist for the fall term, has taught at Indiana, Washington, and Arkansas universities and at summer sessions of the Art Students League at Woodstock. He has studied at the Art Institute of Chicago and in Mexico.

Roland A. Wank, who was here as visiting critic until October 30, was formerly chief architect in the Tennessee Valley Authority, chief consulting architect in the Rural Electrification Administration, and chief designer for Albert Kahn and Associates. A partner in the firm of Fellheimer and Wagner, New York, he has studied architecture in Hungary and Czechoslavakia.

Edward Wormley was visiting critic from November 1-20. An independent designer, Mr. Wormley lists among his clients Alexander Smith Carpets, RCA-Victor, Rand-McNally and Drexel Furniture Corp., and was formerly an executive designer for Dunbar Furniture Co. He has studied at the Art Institute of Chicago and in Europe.

Visiting critic from November 29-December 4, John W. Ross is contractor-president of John W. Ross, Inc. Builders, in Bedford, N. Y. He was formerly vice president of William L. Crow Construction Co. and of the Albert B. Ashforth real estate company in New York. Mr. Ross received the bachelor of architecture from Cornell in 1920.

Caleb Hornbostel, who was a visiting critic at Cornell in 1951-52, is here from December 6-January 22. A New York architect, he has taught at Cooper Union, Pratt Institute, and New York University. He received the bachelor of architecture from Carnegie Institute of Technology in 1929, and the Diplome par le Gouvernment Francais in 1933.

Henry Elder will be visiting critic during the spring term. As head of a research unit in the British House Office, Mr. Elder visited the United States, Germany and Belgium. He was on a British Mission to Japan in 1945 to study the effects of the atom bomb. Formerly senior lecturer at Manchester Municipal School of Art and senior studio master at Architectural Association School of Architecture in London, he is a partner in Elder and DePrero, Chartered Architects, London.

Geodesic Dome on Display

A geodesic dome based on work done at Cornell last year by seniors in the College of Architecture was among seven Buckminster Fuller structures shown publicly last summer at the Marine Corps base at Quantico, Va.

Mr. Fuller, while a visiting critic in the college, supervised work on a dome made of cardboard diamonds stapled together, and coated with a plastic. He believes such domes may replace the tents which armies have used for centuries.

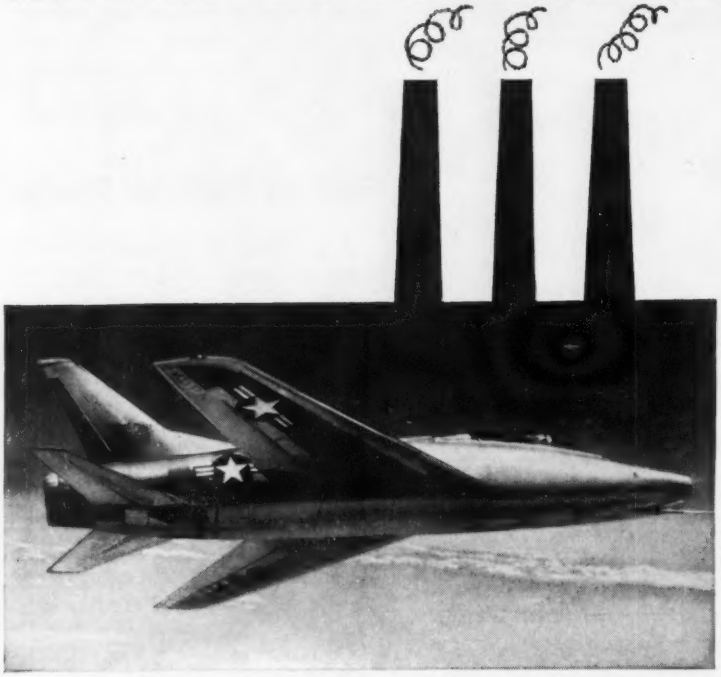
Calculator to be Installed

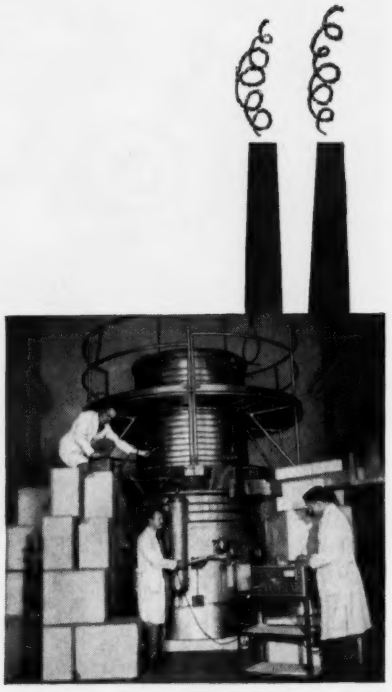
Phillips Hall, the building now under construction for the Electrical Engineering School, is going to house some equipment which should prove profitable as well as useful and educational. An electrical network calculator, to be used in conjunction with the digital computer, or "mechanical brain," located in Rand Hall, will be installed on completion of the new building in a specially lighted, air-conditioned, and acoustically treated room.

This calculator will be in many ways similar to the calculator now in use at the University for determining rate of flow, pressures, and other such useful data in networks of fluid pipelines. That is, the new calculator performs these same functions on electrical power networks. The digital computer is a necessary tool in the use of both these calculators.

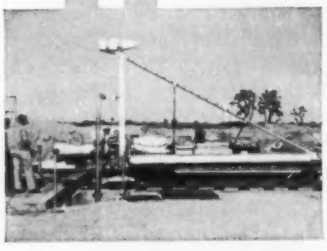
The new calculator has a triple duty. The two obvious functions are in education and research; the third is that it will soon be made available for rental by utility companies. Since network calculations are exceedingly difficult without this new apparatus, it will mean a saving of both time and money for the renting companies, as well as a profit for the University.

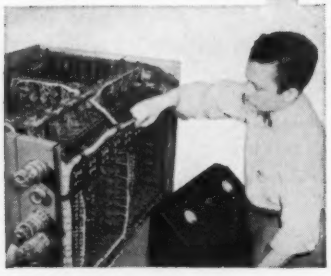
NORTH AMERICAN HAS BUILT MORE AIRPLANES THAN ANY OTHER COMPANY IN THE WORLD





DIVERSITY CREATES OPPORTUNITY





Although best known for design and production of world-famous aircraft like the Korea-famed F-86 *Sabre* Jet and the new, record-smashing F-100 *Super Sabre* . . . North American Aviation also offers engineers excellent opportunities in other technical fields.

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A Campus-to-Career Case History

"Always something new"

"Different types of work appeal to different men," says Donald O'Brian (A.B., Indiana, '50), in the Traffic Department with Indiana Bell Telephone Company. "For me, I'll take a job that keeps me hopping. And that's just the kind of job I have.

"You'd think that after two years I'd have all the variables pinned down. But it doesn't work that way. When you supervise telephone service for thousands of different customers whose needs are always changing, there's always something new coming up.

"I started with Indiana Bell in 1952, after two years in the Army. My training program exposed me to many different kinds of telephone work—customer contact, personnel, accounting, operations. I saw a lot of jobs which looked as interesting as mine. As much as I like what I'm doing now, I bet I'll like my next spot even better."

Don's enthusiasm for his job is pretty typical of how most young college men feel about their telephone careers. Perhaps you'd be interested in a similar opportunity with a Bell Telephone operating company, such as Indiana Bell . . . or with Bell Telephone Laboratories, Western Electric or Sandia Corporation. See your Placement Officer for more information.

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"I chose Worthington for opportunities in international trade"

• "Worthington was my choice," Mr. Berger says, "because of the excellent training and the unusual experiences that are possible with a manufacturer having a worldwide reputation, and worldwide distribution. Then, when a company has seventeen divisions, including air conditioning, refrigeration, turbines, Diesel engines, compressors and pumps of all kinds, construction machinery, and power transmission equipment, a graduate engineer's chances for getting into his chosen field are even better.

"Supporting these divisions are research, engineering, production, purchasing, and sales, domestic and export. The real opportunity, however, is in Worthington itself. This is a company that is growing, just as it has for more than a century. It is always looking for new, related products and good men to engineer, produce, and sell them—at home and abroad.

"I began my career with Worthington's training program in the Research and Development Laboratory, where full-scale equipment is designed, tested and improved. This experience gave me an understanding of the tremendous part the company plays in the everyday life of millions of people. Within fourteen months I was sent to Mexico to inspect the facilities of our distributors there.

"The opportunities for first-hand laboratory experience, sales training and contact, travel and field trips, among many others, make Worthington a first-rate company for the young engineer with a desire to learn and progress in his work."

When you're thinking of a good job, think *high*—think *Worthington.*

8.26

FOR ADDITIONAL INFORMATION, see your College Placement Bureau, or write to the Personnel and Training Department, Worthington Corporation, Harrison, N. J.

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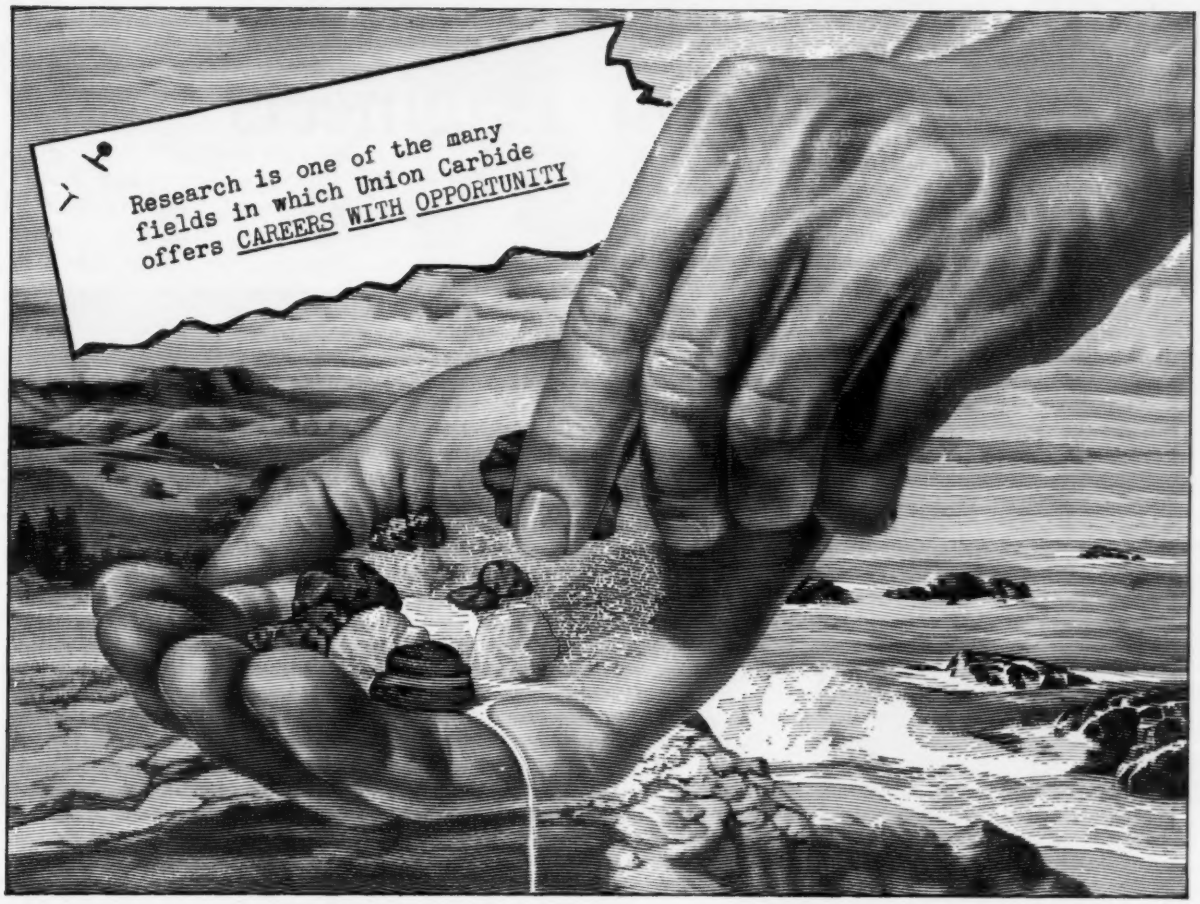

Search is exciting!

Scientists are constantly probing deeper into the secrets of nature —bringing new and better things to you

AS THE PROSPECTOR thrills to the search for treasure, so does the scientist as he searches out the secrets of the earth, air, and water.

THE TREASURE that the scientist seeks is better understanding of nature, and ways to bring better living for all of us. To find them, he is constantly probing, taking the elements apart, putting them back together in different ways—always looking for something new and promising.

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SEARCH . . . RESEARCH? To the scientists of Union Carbide, search and research are the same—an exciting key to a brighter future for all.

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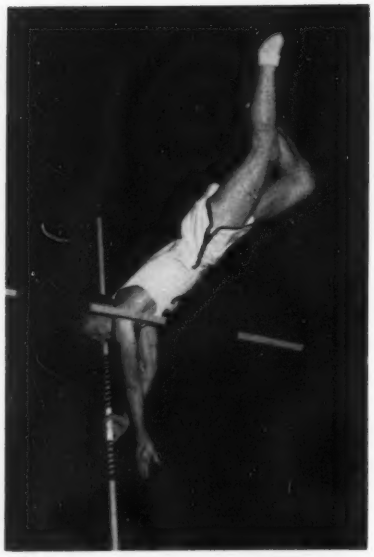
Prominent Engineers



Norm Beachley, ME '56

"Oh—He'd fly through the air with the greatest of ease, That daring young man on the flying trapeze . . ."

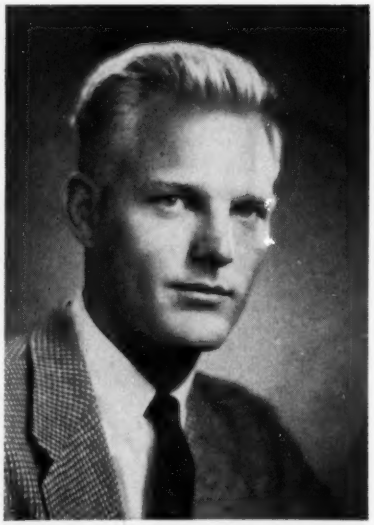
Like that "daring young man on the flying trapeze," Norm Beachley spends much of his time flying through the air, as the number one pole-vaulter of the Cornell varsity track team.

Norm was born and raised in Arlington, Virginia. He attended Washington and Lee High School where he was a two letter man in baseball and track. Evidencing his versatility, Norm was also valedictorian of his class. At Cornell, Norm has continued to excell in both academics and athletics. He played frosh football and has won two letters in track, while maintaing a fine scholastic record. He has been on the Engineering College's Dean's List for three straight years and is at present fourth in his class. He is Vice-President of the Spiked Shoe Society and is a member of Kappa Sigma Fraternity, Quill and Dagger, Pi Tau Sigma, and Scabbard and Blade.

Norm has the usual engineer's hobby — a car. His 1939 Buick, nearly a handbuilt classic, is known as "Leaping Lena" because of its peculiar road-holding habits. Norm is an archery fan, making his own bows and arrows. He is also an accomplished musician, playing the guitar and piano, the latter in an extraordinarily soothing and cheering manner.

The future indicates travel, dressed in blue or khaki. After this Norm may do graduate work in aeronautical engineering or go into research work in the automotive field.

Beachley is a Heptagonal titleholder, having placed 1st in the pole vault at the Outdoor Heps last Spring at Harvard. However his best meet was last Spring's Penn-Cornell meet; by winning the pole-vault event with a jump of 13'2½". Norm won a trip to Europe with several other Pennsylvania and Cornell stars. This team participated in two European meets: a joint meet with Oxford and Cambridge, and an international meet in Brussels, Belgium. Norm placed second in both meets, tieing the French national champion and losing to the Italian national champion in the international meet. After the Brussels' meet, the team broke up into small groups for short tours of Europe. Norm bicycled through Belgium, Holland, Germany, Switzerland, and France, arriving in Paris with $1.00 in francs and a ticket home in his pocket. The high point of this trip came as Norm was resting by a French roadside. A small auto stopped and a frantic Frenchman harangued Norm with an unintelligible verbal barrage. Finally deciphering a question mark after the word "Paree," Norm pointed in the direction of Paris. With effusive thanks the driver departed, probably the only Frenchman ever shown the way to Paris by a Virginia boy.



Bob Kahle

ROBERT KAHLE, ME '55

Born in Mexico, educated in Venezeula and Oklahoma, and a success at Cornell: Bob Kahle. This very personable and talented young man will undoubtedly be one of Cornell's finest graduates.

Bob went to grade school in Venezuela and to high school in Tulsa, Oklahoma. There he was President of the Thespian Society and the Speakers Bureau. As top man in his high school, he competed with boys from 99 other schools for an American Institute of Steel Construction Scholarship, which he won.

At Cornell Bob has been active in many phases of University life. Last year he was Secretary of the Men's Judiciary Board and is now Chairman. He was active in CURW for four years, being vice-president his senior year. Bob has been on several IFC committees, has been a freshman camp counselor for two years, and chairman of the Bailey Hall freshman orientation show. He

was also a member of the crew for three years. Bob has continued his achievements academically as well. He is number three in his class, has been on the Dean's List for four years, was a Tau Beta Pi Honor Student, and received the Pi Tau Sigma Outstanding Junior Engineer award and the Scott Award for the Outstanding Senior Engineer. Bob is President of Tau Beta Pi and is a member of Chi Psi Fraternity, Pi Tau Sigma, Kappa Tau Chi, Sphinx Head, and Red Key.

His hobbies are sailing on Long Island Sound and skiing. He is double-registered in the business school but his attendance there next year is dependent upon the U.S. Air Force. After the service, his plans are in the field of production or management engineering, for he believes that "engineering is a tool towards business management."

RODNEY ROUGELOT, EE '56

From Chattanooga, Tennessee, the heart of the Southland, Rod Rougelot came to Cornell and, like the marines, took the situation well in hand. He is the number one man in his class in the EE school and has been on the Dean's List for three years. A veritable human dynamo, Rod is always in motion.

Rod Rougelot

His major activity is the Glee Club. As Business Manager, Rod must handle the myriad of problems and arrangements entailed by the shows and tours of this organization. This job occupies approximately thirty hours per week during the first three months of school, after which the time required diminishes slightly. Rod has been an orientation counselor, publicity chairman of the Freshman Orientation Committee, a member of the EE Student Faculty Committee for three years, and an intramural wrestling champion for two years. He is Brigade Commander of all ROTC units at Cornell and as such can be seen weighted down with six gold bars on each side of the collar of his Navy uniform. Rod is a member of Kappa Sigma Fraternity, Quill and Dagger, Eta Kappa Nu, Tau Beta Pi, and Scabbard and Blade. Two years ago he was a recipient of the Eta Kappa Nu Sophomore Award.

As a Regular Midshipman in the NROTC he has visited many parts of the Northern Hemisphere. As a freshman he saw Belgium, Holland, Portugal, and a good part of the Atlantic Ocean. In the summer of his sophomore year Rod took the amphibious and aviation courses at Little Creek, Va., and Corpus Christi, Texas. Last year the Navy showed him France, Scotland, London, and again a good part of the Atlantic Ocean.

Rod is a graduate of Baylor Military Academy, Chattanooga, Tennessee. He was salutatorian of his class and was a letterman in football, baseball, and track.

His immediate future is of course dependent on the U.S. Navy. After that — a question mark. Rod intends to eventually be in the business end of engineering. With his talent, energy, and personality, Rod will be a credit to Cornell wherever he goes.

Helicopters

(Continued from page 18)

but this will not be for a long time.

Development costs are now relatively high, because extensive testing is required on each new model, particularly in connection with rotor systems and control systems.

One possibility for low-cost helicopters for the future may lie in the adaptation of tip power, which eliminates engine weight and transmissions. (The transmission of the $35,000 ship costs as much as an expensive family automobile).

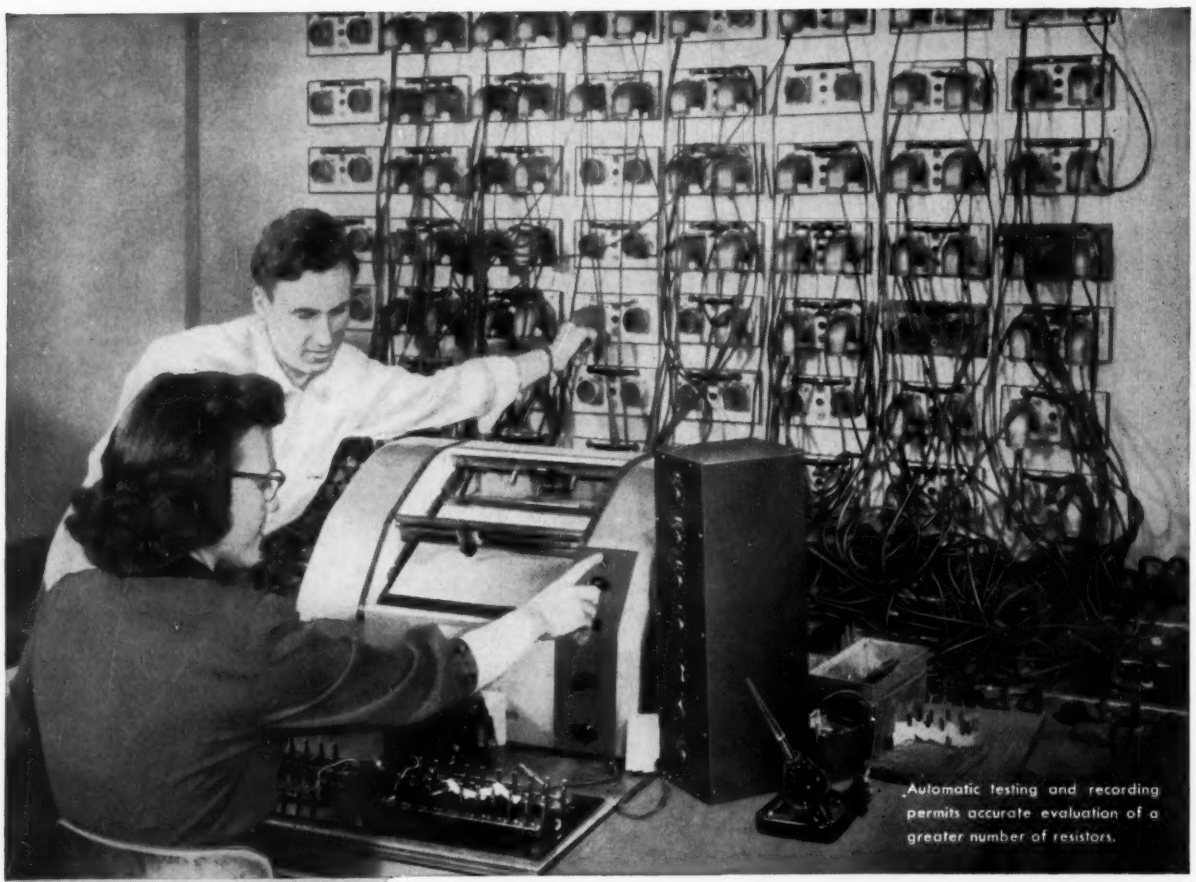
Compound reciprocating engines, however, are likely to offer strong competition to other types for some time to come. The piston engine is not ideally matched to rotor operation, since optimum hovering conditions require a low rotor rpm, and cruise requires high rpm, which is the reverse of rpm requirements imposed on the engine by power conditions in hovering and cruise. For this reason, turbine drives offer some attraction.

The cost of operating the helicopter now used for commercial transport (the Sikorsky S-55) by three U.S. airlines, Mohawk, New York Airways, and National Airlines in Miami, is roughly four times that required to operate a DC-3. The S-55 can carry 7 to 8 passengers.

Commercial air transportation is one field of application which has only lately started to be exploited. The helicopter has the unique advantage of being able to operate from the center of one city to the center of another (see NEWSWEEK, Sept. 20, 1954: *Special Report*). To operate efficiently on short-haul operations will require a 35 to 45 passenger ship. Commercial versions of such helicopters — for example the Piasecki XH-16 — are a number of years off. Airlines companies are now accumulating experience with small-scale helicopter transportation, and are planning toward the availability of larger passenger ships in the future.

PARTIAL LIST OF ACKNOWLEDGMENTS AND REFERENCES:

1. Mr. Harold Hirsch, Chief Helicopter Engineer, Hughes Aircraft.
2. Mr. William Duke, Cornell Aeronautical Laboratory.
3. Hiller Helicopters.
4. Sikorsky Aircraft.
5. National Advisory Committee for Aeronautics (NACA).
6. The American Helicopter Society.
7. Raymond A. Young, *Helicopter Engineering*, The Ronald Press Company, 1949.
8. Alexander H. Flax, *The Bending of Rotor Blades*, Journal of the Aeronautical Sciences, January, 1947.
9. NACA TN 3027
   NACA TN 2648
   NACA TN 2626
   NACA RM L53D02



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SPECIFIC EXAMPLES

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MIL-R-11A Specification

IRC Power Wire Wound Resistors
MIL-R-26B Specification

Type BW Low Wattage Wire Wounds
JAN-R-184 Specification

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JAN-R-29 Specification

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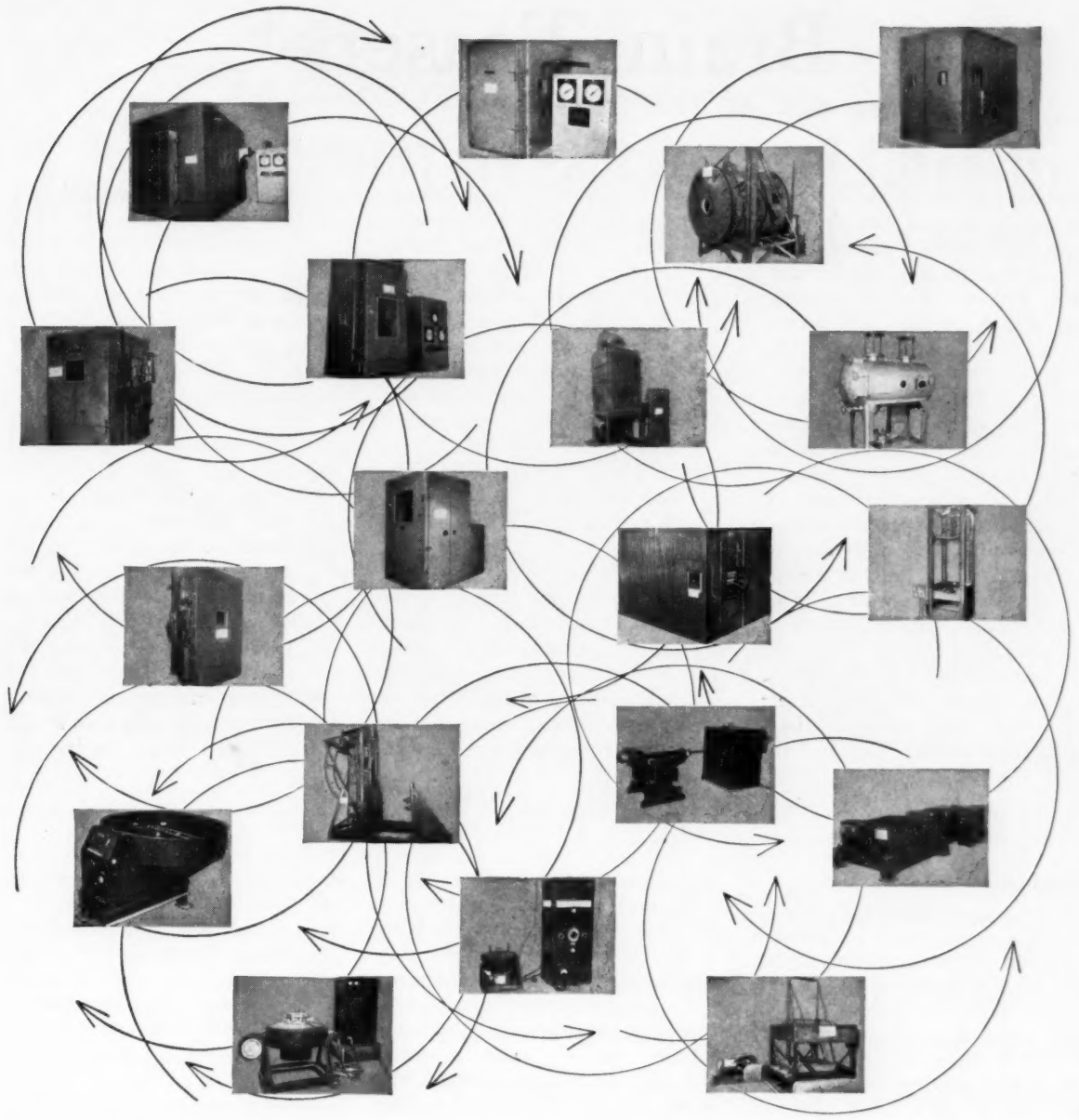

19 chambers of hell

You are looking at the units of a $2,000,000 Martin testing laboratory—part of a man-made hell of fire and water, shock and vibration, explosion and corrosion, designed to torture *electronics equipment!*

For these vital components of today's aircraft, guided missiles and weapons systems must carry tremendous responsibilities. Consider, for example, the electronic system of the Martin B-61 Matador:

Incredibly versatile, it comprises the entire brain and nervous system of America's first successful pilotless bomber. Yet this sensitive equipment must withstand the shock of many tons of thrust in the first second of take-off—violent changes in temperature and pressure—and ground conditions ranging from sand storms to arctic blizzards, desert dryness to tropical downpour.

Today, Martin's facilities are among the finest in the world for design, production and proving in the field of avionics...one of the major developments of Martin Systems Engineering which is now tailoring airpower to previously impossible requirements.

You will hear more about Martin!

MARTIN

BALTIMORE · MARYLAND

Brain Teasers

Having parried all thrusts and thus set the record straight last month, the ENGINEER will now continue its most antagonizing feature: Brain Teasers. We are offering three dollars to the first person who mails us a complete set of correct answers to the following problems. Very little paperwork is required, but ingenuity is indispensible. (Answers in the February issue.)

1. An ambitious grad student decided to measure the size of the earth. Being the owner of a large spool of non-stretching wire, as well as a good bit of endurance, he looped the wire around the earth. (For the sake of general health assume our planet to be a perfect sphere 8,000 miles in diameter.) After our hero had the wire tightly wrapped about the equator, he let out ten more feet, this slack being taken up by lifting the wire off the ground equally around the earth. By letting out that ten feet of wire, how much has this lad increased the diameter of the great circle which the wire forms?
2. A recent editorial read:
   "(746,832) (5,924,810) = 442,48X,770,192"
   What is the blurred digit marked "X"?
3. A freshman left his fraternity house with no money, so he stopped to cash a check. Through an error which neither he nor the teller noticed, he was given as many dollars as the check read cents and as many cents as the check read dollars. He then stopped at a local tavern and bought a few beers — in fact, as many beers as the check read dollars, and he paid as much per beer as the check read cents. When he stopped at the drug store for some aspirin, he found that he had just four times the amount of the check. How much was the bank short at the end of the day?
4. Three movie houses are located on a level plane at the vertices of an equilateral triangle. If I drive around the circuit to see the various shows, I find that it takes me 80 minutes each to travel the first two legs, but an hour and twenty minutes is required for the third. Why does it take so long to travel the last leg?

Cracking

(Continued from page 11)

Company. The main features of this unit are simplicity of design and straight lines of catalyst transfer from one zone to the other. In all Orthoflow units the reactor and regenerator are positioned vertically above each other. In the Orthoflow units the reactor and catalyst flows through a plug valve at the bottom of the regenerator. In the valve the catalyst is mixed with liquid charge fed through the stem of the valve. The oil vaporizes and carries the catalyst to the regenerator where the reaction is completed. Cracked vapors disengage from the catalyst and pass up through a cyclone separator at the top of the reactor. Spent catalyst passes through openings in a verticle partition in the reactor into the stripping zone where the remaining hydrocarbons are purged with steam. The spent catalyst flows through a standpipe at the bottom of the stripping section to the regenerator.

In the Orthoflow B units regenerator is positioned above the reactor. The spent catalyst stripping zone is in the center of the reactor and stripper spent catalyst is carried to the regenerator by combustion air which is admitted through the hollow stem of the spent catalyst valve. Regenerated catalyst flows vertically downward from the regenerator and is contacted with oil feed in the base of the reactor.

At present there are twelve Orthoflow units under construction or in operation. Orthoflow A units vary in size from 2000 to 10,000 barrels per day of fresh feed while Orthoflow B units have a capacity as high as 28,000 barrels per day of fresh feed with a reactor throughput of 45,000 barrels per day.

Design Consideration

In all the previously discussed units emphasis is placed on simplicity of design, low catalyst attrition, high gasoline recovery, and a minimum of shutdown time. In addition, ease of maintance, operating cost, and the ability to handle a wide variety of charging stocks are particularly important. On-stream efficiency and reliability is particularly important in these units. For a 5000 barrel per stream day unit, with a marginal operating profit of $0.50 to $1.00 per barrel, a 5 per cent increase in on-stream efficiency means increased earnings of from $26,500 to $53,000 per year.

To prevent unnecessary shutdowns particular attention must be paid to materials of construction. High-temperature hydrogen sulfide corrosion in the reactors, corrosion from oxides of sulfur in the regenerator, and catalyst abrasion are particular problems. Where erosion is a problem, carbon steel is preferable to moly and stainless steels which have higher corrosion resistance. In the reactor 12 per cent chromium alloy steel is usually recommended. The regenerators are usually constructed of stainless steel or carbon steel with a heavy corrosion allowance.

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Technibriefs

A new disc type speedometer, known as the "Safety Arc," which indicates speed by a continous curved line, is now in production at AC Spark Plug Division of General Motors.

Besides being unusually attractive, the new speedometer design has a decided safety feature. While the speedometer is compact, speed is clearly indicated by a bold red line on a semi-circular dial. The continuous red line flows from left to right across the speed markings as the car accelerates. In decelerating, the line flows back toward zero.

The brilliance of the line, both day and night, gives the driver two quick indications of his speed. First he notes the speed indicated by the figures at the end of the red line. Second, the length of the line itself is an automatic indication of speed.

Research and experimentation has proven that the bright red 'flowing' line is the most impressive way yet discovered of indicating car speed. Since the speed line lengthens with the increase of car speed, its length tends to make a driver more speed conscious at all times.

The total milage meter is located away from the "speed line" for clear reading of both speed and mileage.

In addition, a new and more efficient dampening feature has been used to eliminate any chance of speedometer noise or vibration. The dampening has been accomplished through use of non-metallic washers and silicone liquid.

Rapid Test of Lamp Life

Scientists can now almost instantly predict approximately how long a particular fluorescent lamp will burn—something which formerly could be found out only by burning it until it blinked out after an average period of 7500 hours.

This was revealed by Richard N. Thayer, lamp development engineer for General Electric at Nela Park, Cleveland, in a paper on "Determinants of Fluorescent Lamp Life," presented at the National Technical Conference of the Illuminating Engineering Society.

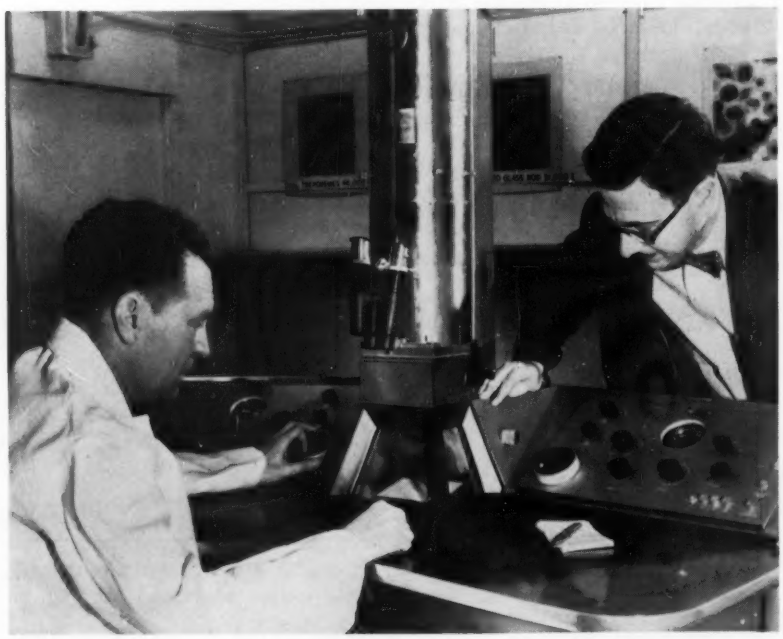
Other things being equal, the life of a fluorescent lamp is proportional, according to Thayer, to the amount of a chemical, called "emission coating," held by the lamp's cathode. By weighing this emission material, which serves as the source of electrons to carry the current through the lamp, the life of a lamp can be estimated.

The development engineer said his organization had developed an electronic method which permits rapid testing of fluorescent lamps for the quantity of chemical on their cathodes without breaking open or even lighting the tubes.

In this method, Thayer explained, the lamp under test is compared in an electronic circuit with a lamp having an uncoated cathode. When the current is applied, the coated cathode is slower to increase in temperature. This difference in resistance to heating is roughly proportional to the weight of the emission coating, and can be read on a meter.

The getting the desired quality of chemical on the cathode, and retaining it there through all lamp processing and handling steps, requires close controls, according to the G-E engineer. He said many checks are made to insure high quality. The new electronic tester is said to be an especially useful control tool in detecting short-life lamps.

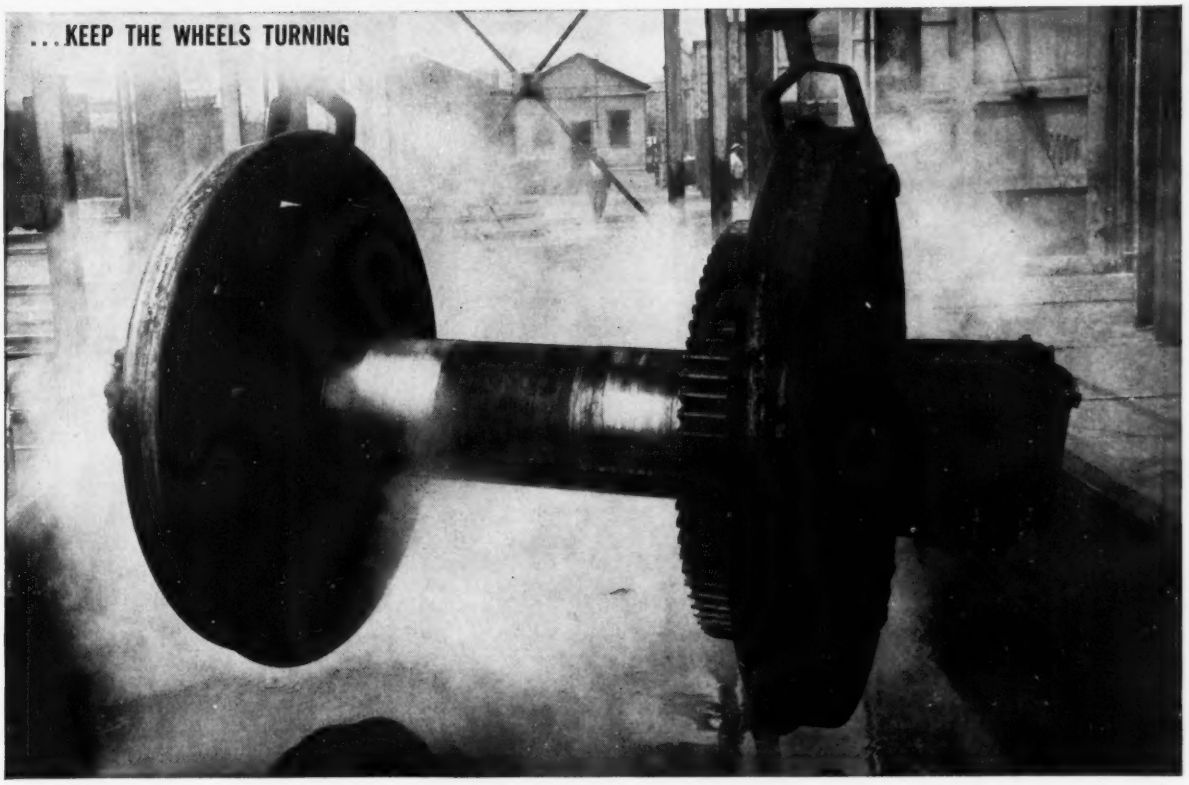
This new electron microscope, which is twice as powerful as previous instruments, will enable scientists to examine bacteria and other matter smaller than 1/10 millionth of an inch and provide useful magnification up to 200,000 times.



New Radiation Detector Developed

Alpha Poppy is not the name of a flower or a new college fraternity, but the name chosen by General Electric engineers for a new radiation detector. It looks like the common conception of a futuristic ray gun, but it doesn't send rays; it "catches" them.

The device is designed to check



CHEMICAL BATH—Hercules Dresinate®, added to alkaline cleaners, increases the efficiency of cleaning solutions for large equipment such as these railroad wheels. In other applications—as an emulsifier, detergent, dispersant, foaming and flotation agent—this water-soluble resinate helps increase performance, reduce cost of other compounds.

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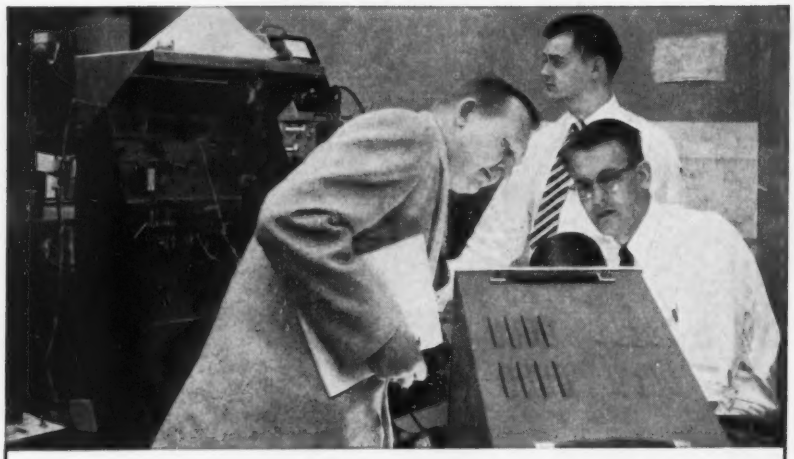

ENGINEERING WRITING

Here is an ideal way for the engineer or physicist with some aptitude for writing to enter the field of advanced electronics. In this relatively new and expanding area you can make immediate and effective use of your academic training while acquiring additional experience.

Hughes Research and Development Laboratories are engaged in a continuing program for design and manufacture of integrated radar and fire control systems in military all-weather interceptor aircraft. Engineers who produce the maintenance and operational handbooks for this equipment work directly with engineers and scientists engaged in development of radar fire control systems, electronic computers, and other advanced electronic systems and devices.

Your effort in the field of engineering writing through these publications transmits information to other engineers and technical personnel on operation, maintenance and modification of Hughes equipment in the field.

You will receive additional training in the Laboratories at full pay to become familiar with Hughes equipment. Seminars are conducted by publications specialists to orient new writers. After-hours graduate courses under Company sponsorship are available at nearby universities.

HUGHES
RESEARCH AND DEVELOPMENT LABORATORIES

SCIENTIFIC AND ENGINEERING STAFF

Culver City, Los Angeles County, California

Photograph above: Engineer-writer John Burnett (left) works with engineers John H. Haughawout (right) and Donald King to compile handbook information.

work areas and clothing for sources of alpha radiation, which can be dangerous if absorbed internally. It will often be used with equipment that sends out warning "pops" when alpha contamination is detected; hence the odd name.

A tiny bit of radioactive material no larger than a pinhead will emit alpha particles for thousands of years. Since alpha radiation quickly dissipates its energy in air, it is normally harmless except when a source of such radiation becomes lodged inside the body.

The "muzzle" of the pistol-like Alpha Poppy is passed close over the areas of suspected contamination. Tissue-thin aluminum foil lets in alpha rays, but keeps out ordinary light.

The alpha rays are "caught" by a zinc sulphide screen, which causes them to expend their energy, creating light. The light is converted to electrical impulses, which are amplified thousands of times and can be used to obtain an audible or visible signal.

X-ray Magnification

X-rays are used to look inside all sorts of things, ranging from huge castings to the human body. Now scientists will soon have at their disposal a new General Electric Company instrument that will enable them to magnify and X-ray subjects smaller than the human eye can see.

Called the X-ray microscope, this instrument is capable of wide use in medical science, biology and industry. The device magnifies up to 1,500 diameters and permits the study of grain structure in metals, the cell structure of bones and human tissue and the internal organs of tiny insects and other subjects opaque to light.

Scientists in the laboratories of the U.S. and Euorpean countries have long endeavored to develop a practical device of this kind that can be produced in quantity. The principal feature of the instrument is an electro-static lens system that provides an X-ray source 300 times smaller than a human hair. This is important because the larger the X-ray source, the lower the poten-

This U. S. Navy Neptune P2V-7's outthrust "Stinger" tail tells tales on submarines—spots them underwater with secret apparatus.

tial magnification of specimens.

A conventional X-ray source cannot be made smaller than about one-eight inch in diameter, and even a source as small as one 1,000th of an inch gives magnification no greater than an ordinary reading glass.

Work Completed on New Rifle

A lightweight recoilless rifle and new-type ammunition with unprecedented tank-killing power have been unveiled by the Army Ordnance Corps in Lacarne, Ohio.

The weapon, a 106 mm battalion anti-tank rifle known as "The BAT," has doubled the penetrating power of any existing recoilless rifle. Weighing less than 500 pounds, it can be carried by three men or mounted in a Jeep.

Development work began on the rifle shortly after the start of the Korean war, but production did not start until last fall. It is now being produced by Firestone.

One of the features of the weapon is a rigidly mounted .50 caliber spotting rifle which permits greater fire control and speed in moving on a target. By firing tracers, the spotting rifle eliminates the need for a heavy and fragile optical rangefinder.

The BAT, measuring approximately 10 feet in length, can be mounted or dismounted from a Jeep or ¼-ton truck in less than a minute. It enables foot soldiers to meet tanks on even terms for the first time.

"Pin Ball Machine" Tests

A scientific "pin-ball machine" is being used to speed up testing one of the Army's newest defense weapons — the Skysweeper.

Rows of lights mounted on the front of the device flash on and off as it quickly and automatically tests hundreds of electrical connections in the Skysweeper for shorts and breaks.

The light flashing stops if a faulty connection is found.

In each Skysweeper — an electronic artillery machine gun built to seek out and destroy invading fighter planes — there are eleven wiring harnesses. Each has as much as a half mile of wire and 800 connector points.

The new machine can test the largest of these harnesses in less than an hour. Former test procedures took 40 hours.

Inner parts of the device include nearly a half mile of wire, 1,000 connector points, 525 separate relays and six automatic stepping switches.

Leading from the machine and mounted on an adjoining table are

The design engineer trained in welded steel construction is best able to meet industry's need for low cost manufacture because

WELDED DESIGNS CUT COSTS 50%

BY using steel instead of cast iron, design engineers today make their products more efficient . . . *many times at half the cost.* Product designs are stronger, more rigid, take less material to build.

Too little attention is usually devoted to simplification of product designs to eliminate costly manufacturing manhours once a basic design is established. Where designers reappraise product details for welded steel construction, production costs are being cut an average of 50% compared with manufacture using castings.

Manufacturing operations are simplified with welded steel design. Rejections due to inferior metal are eliminated. Less machining and finishing are required. Finished machines are streamlined, more modern in appearance.

In the example below, an economy-minded design engineer lowered manufacturing cost on a machine arm and cut weight of the arm.

Before conversion to steel, the machine arm required 182 pounds of gray iron and cost $38.25 to cast and machine. Welded steel design weighs only 86.8 pounds . . . costs $20.06.

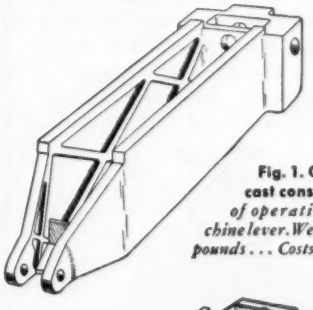

Fig. 1. Original cast construction *of operating machine lever. Weighs 182 pounds . . . Costs $38.25.*

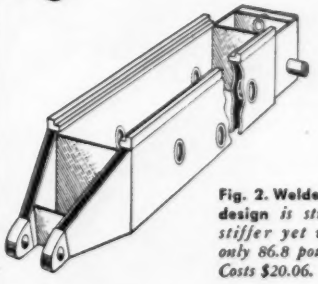

Fig. 2. Welded steel design *is stronger, stiffer yet weighs only 86.8 pounds . . . Costs $20.06.*

DESIGN DATA *for welded construction is available to engineering students in the form of bulletins and handbooks. Write*

THE LINCOLN ELECTRIC COMPANY
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THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

12 plug-tipped wires, each with 75 contacts. These are connected to contacts on the skysweeper wiring harness in much the same way as an ordinary table lamp is plugged into a wall socket.

The rows of lights mounted on the front panel of the device provide a visual method of following the automatic testing operation. The top row of lights are consecutively numbered from one through nine; the second row, 10, 20, 30 through 90; the bottom row, 100, 200, 300 through 1,000. Wires on the harness are similarly numbered so any short or break in a wire can immediately be seen on a corresponding light.

Radar Eye for Jet Bombers

A remote controlled tail turret system, capable of knocking down enemy interceptors in the night or fog, will protect the Air Force's Boeing B-47E Stratojet bomber.

The turret gives the six-jet bomber a heavyweight punch to the rear and, guided by radar, it can track and shoot down unseen targets. It is especially adapted for high speed jet airplane operation.

Radar "eyes" that pierce the blackest night are provided on the Air Force's Boeing B-47E Stratojet bomber by the General Electric Company-designed radar-controlled tail turret.

The gun-firing system has been designed so that radar and an "Electric Brain" will do most of the work.

The Air Force revealed that it has been delivering these armament units for nearly three years.

In danger areas, the radar is switched to "search". With this done, the radar maintains a watch to the rear.

When the radar picks up an attacking plane, a "pip" shows up on the radar screen.

Once the target is centered in the crosshairs, it is tracked automatically. This tracking action supplies the computer with the information it needs, and when the attacking plane gets into range, the gun is fired.

The system consists essentially of a tail turret mounting two guns, a computer, control equipment, and search-track radar.

World's First "Speedwalk"

The world's first commercial moving sidewalk soon will be in operation between the stations of the Erie Railroad and the Hudson and Manhattan Railroad in Jersey City, N. J. It will be capable of handling 10,400 passengers an hour through the interstation tunnel.

The 227-foot conveyor, being built by the Goodyear Tire and Rubber Co. and the Stephens-Adamson Manufacturing Co., is called a "Speedwalk."

The new conveyor will utilize a six-ply rubber and fabric conveyor

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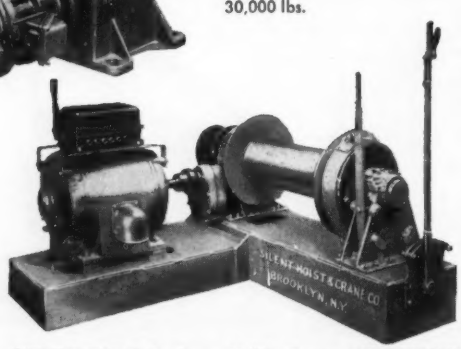
6,000 lbs.	12,000 lbs.
12,000 lbs.	24,000 lbs.
18,000 lbs.	40,000 lbs.
22,000 lbs.	
30,000 lbs.	



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Barnes Hall

belt, 5½ feet wide and ⅝ in. thick. It will be driven at a speed of 1½ miles per hour (about half normal walking speed). For 127 feet of its length, the Speedwalk will carry passengers on a 10 per cent grade.

Handrails will move at the same speed as the belt and passengers will be able to step on and off as if it were an escalator. The belt will move in whichever direction the traffic is heavier.

Plastic Boats Make Appearance

Wide beam 16 foot glass plastic "assault boats" weighing less than 300 pounds are now being produced by Universal Moulded Products Corporation of Bristol, Va., for service testing by the Army Corps of Engineers. Engineering tests on plastic boats have already been successfully completed.

Designed for assault crossings of rivers and streams, the boats are strong enough to carry 15 men with full packs, yet light enough to be readily hand carried. They are laminated under 65 pound pressure by use of a light gauge, inexpensive steel mould and a preformed rubber blanket which serves to provide the vacuum pressure prior to the application of additional pressure and heat to the laminate in a large autoclave.

The purpose of the additional autoclave pressure is a thorough "wetting out" of the glass fibers by the resin, which in turn guarantees uniformity in mass production. For quick detection of "starved areas" which sometimes occur in plastic laminates, these boats are not pigmented or painted prior to inspection by the Engineers.

Boats laminated by this close quality control process are expected to be competitive with boats produced by other techniques.

The successful performance of these "assault boats" in forthcoming tests may contribute materially to the military's adopting fiber glass plastics for the construction of many small landing craft.

Atomic Energy

(Continued from page 15)

corrosive a material as can be produced. Lubricants, seals, waxes, and other essentials to the process, must resist the corrosive action of the gas. The only suitable materials of which these could be made were compounds of fluorine, or fluorcarbons; these substances resist not only UF_6 but also nearly every other corrosive material known. Thus there emerged as a by-product of the production of U-235 a material which has found application in the fabrication of plastics, oils, and paints with remarkable properties.

H-Bomb

The thermonuclear, or hyrogen bomb, has since 1951, superseded the atomic bomb, and therefore any discussion such as this which excluded the fusion process would be highly inappropriate. Fusion involves the welding together of hydrogen atoms to form helium atoms. This is the process which occurs in the sun, and which liberates a thousand-fold more energy than the fission of uranium or plutonium atoms. Ordinary hydrogen atoms, however, refuse to fuse; two rare isotopes of hydrogen, tritium and deuterium, the latter occuring in nature and the former manufactured in much the same way as pluton ium, will perform the fusion process in an H-bomb. High temperatures of the order of millions of degrees as exist on the sun, are necessary for the initiation of the fusion process, and these are provided by the detonation of an ordinary A-bomb.

Conclusion

The scope of this nation's atomic energy program may be realized by the setting down of a few significant statistics. The construction and maintenance of the Oak Ridge and Hanford plants has necessitated the establishment of two towns of over 30,000 population each in the states of Washington and Tennessee. The concrete poured at the Savannah River plant would suffice to lay a sidewalk five feet wide and six inches thick from coast to coast, and the earth removed in excavation work would build a wall ten feet high and 6 feet thick from Los Angeles to Boston. The labor force currently engaged in the program numbers 65,000 or five per cent of the nation's total construction force. These are but a few of the amazing facts about history's most gigantic industrial undertaking.

Ingenuity...

A Key to K&E Leadership

To design a slide rule that makes even the most complex calculations simple takes ingenuity. Years of ingenious developments and improvements by K&E, first to make slide rules in America, produced the Log Log Duplex Decitrig®, the slide rule most used by engineers and students alike. Ingenuity—of design, of manufacture—is one of the keys to K&E's eighty-seven years of leadership in drafting, reproduction, surveying and optical tooling equipment and materials, in slide rules and measuring tapes.

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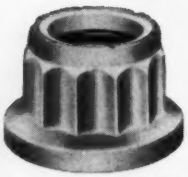
self-locking fasteners

Elastic Stop nuts

HEX NUT

SPLINE NUT

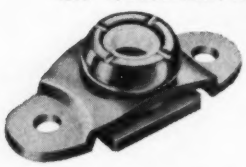


HIGH TENSILE NUT

CLINCH NUT

1200° F. HIGH-TEMP. NUT

GANG CHANNEL NUTS



FLOATING ANCHOR NUT

Every major aircraft now being assembled relies on the vibration-proof holding power of ELASTIC STOP nuts. Only ESNA manufactures a complete line of all types and sizes of self-locking nuts.

Rollpins

dia. from 1/16" to 1/2"

Rollpins are slotted, tubular steel, pressed-fit pins with chamfered ends. They drive easily into holes drilled to normal tolerances, compressing as driven. Extra assembly steps like hole reaming or peening are eliminated. Rollpins *lock* in place, yet are readily removed with a punch and may be reused.

Cut assembly costs by using Rollpins as set screws, positioning dowels, clevis or hinge pins. Specify them in place of straight, serrated, tapered or cotter type pins.

ESNA TRADE MARK

ELASTIC STOP NUT CORPORATION OF AMERICA

ROLLPIN TRADEMARK

Mail Coupon for Design information

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Dept. N34-152, 2330 Vauxhall Road, Union, N. J.

Please send me the following free fastening information:

- ☐ Elastic Stop Nut Bulletin
- ☐ Rollpin Bulletin
- ☐ AN-ESNA Conversion Chart
- ☐ Here is a drawing of our product. What fastener would you suggest?

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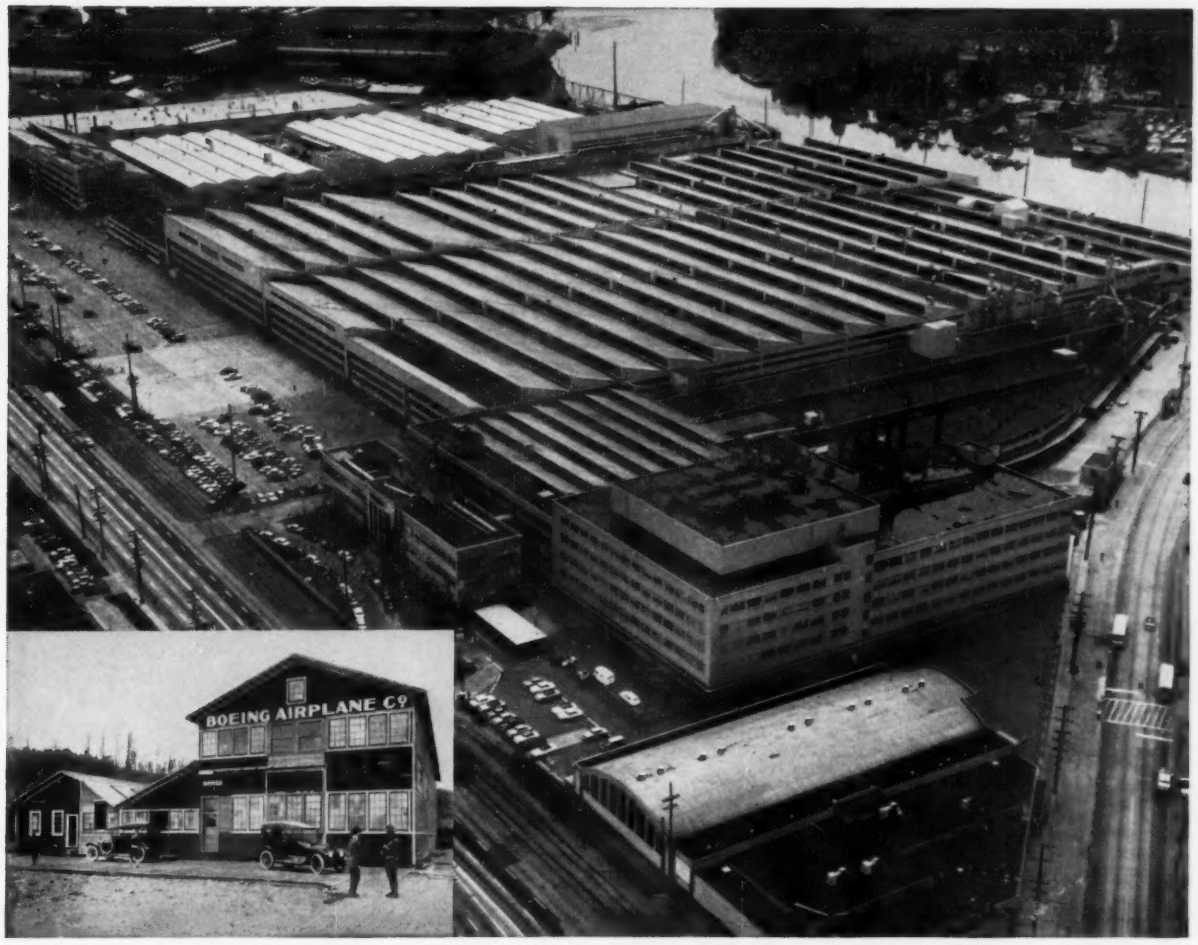
City_____ Zone___ State_____

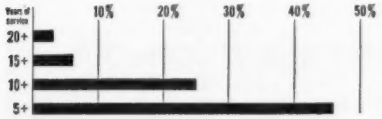


1916—The first Boeing plant, Seattle

1954—Boeing's Seattle plant as it appears today. New Engineering Building is shown in foreground.

Is career stability important to you?

Then the chart below will be of interest. It shows that 46% of Boeing's engineers have been with this company for five or more years; 25% have been here 10 or more years, and 6% for 15 years.



One reason for this stability is that Boeing has grown steadily for 38 years, providing plenty of room for advancement. Another reason is the highly interesting type of work at Boeing, such as designing and building America's first jet transport and the revolutionary B-47 and B-52 jet bombers, as well as work on pilotless aircraft, supersonic flight and research in nuclear-powered aircraft.

Still another reason is this: Boeing always has put dominant emphasis on engineering development. Pioneering in this field has meant that Boeing constantly has increased its engineering staff in relation to total employees. Fifteen years ago, one out of 16 employees was in engineering. Five years ago the proportion of engineers had been raised to one in ten and today it has climbed to one in seven.

Boeing has rewarding openings for engineers of EVERY category—electrical, civil, mechanical, aeronautical and related fields, as well as for applied physicists and mathematicians with advanced degrees.

Careers at Boeing afford a wide variety of experience in research, design and production, as well as work with new materials and techniques, and contacts with a cross section of industry through Boeing's vast subcontracting program.

Boeing promotes from within and holds regular merit reviews to assure individual recognition. Engineers are encouraged to take graduate studies while working and are reimbursed for all tuition expense.

For further Boeing career information consult your PLACEMENT OFFICE, or write

JOHN C. SANDERS, Staff Engineer — Personnel
Boeing Airplane Company, Seattle 14, Wash.

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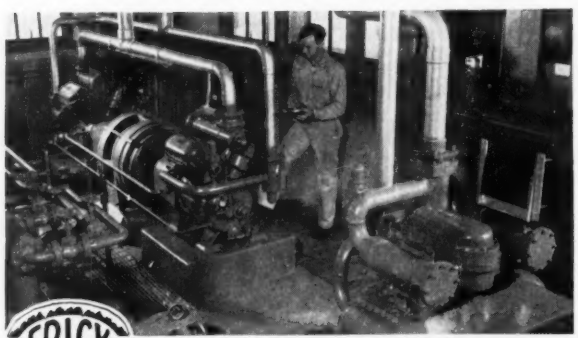

FRICK

REFRIGERATION HELPS MAINTAIN 5,000 M.P.H. SPEEDS IN WIND TUNNELS

For testing aircraft at speeds up to 5,000 m.p.h., the National Advisory Committee for Aeronautics operates several large wind tunnels at Ames Aeronautical Laboratory near San Francisco.

The energy expended in compressing the air to over 72 pounds pressure would result in overheating and excessive water content, but for the special Frick cooling and conditioning system illustrated.

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THE CORNELL ENGINEER

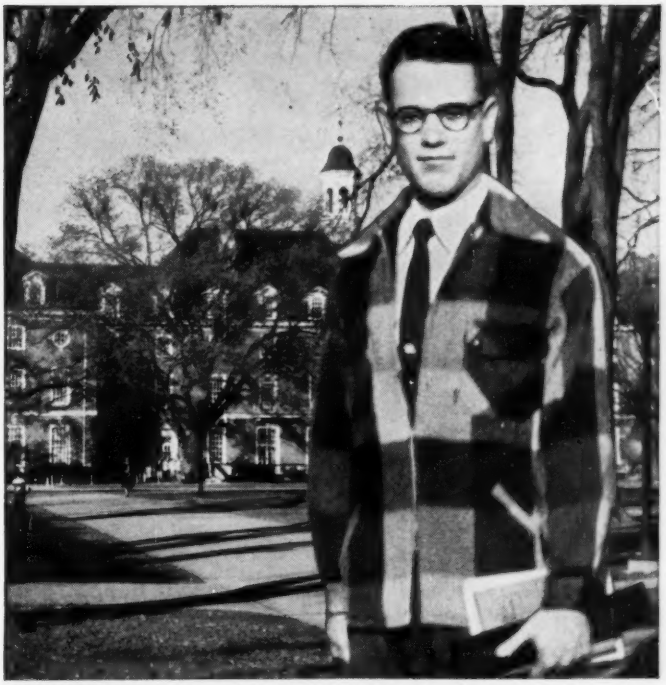
WISHES ITS READERS

A PLEASANT AND PROSPEROUS

NEW YEAR

Bill Zartman wants to know:

What effect would an advanced degree have on my opportunities for advancement at Du Pont?



William N. Zartman is studying for a B.S. in Chemical Engineering at the University of Illinois. Last summer he worked in the Technical Laboratory at Du Pont's Chambers Works to gain industrial experience. He has not yet selected a permanent employer, however; and right now he's asking the kind of questions which will help him select the right job and plan a successful career.

Dr. Sheldon Isakoff received his Ph.D. degree in Chemical Engineering from Columbia University in 1952, doing his graduate research work on the problem of heat transfer in liquid metals. Since graduation he's been engaged in fundamental research work at the Du Pont Experimental Station, Wilmington, Delaware. Dr. Isakoff is now a Research Project Engineer in the Engineering Research Laboratory.

Sheldon Isakoff answers:

An advanced degree would undoubtedly have a *favorable* effect in technical work, Bill, but let me enlarge on that just a little. In my own field—chemical engineering—a doctorate is considered to be evidence of demonstrated ability in carrying out original research. An advanced technical degree is therefore helpful in obtaining work in research and development, where that skill is definitely important. You might say it gives a man a head start in proving his ability in those areas.

It's less important in some other areas, though. For example, in production or sales work a manifest ability for handling human relationships is just as important for advancement as technical competence. If an engineer is sold on production work or sales, a graduate degree in marketing or business administration might be more helpful to him than advanced technical training—in getting started.

But I've noticed this at Du Pont. Once a man lands a job in his chosen field and actually begins to work, his subsequent advancement depends more on demonstrated ability than on college degrees. That's true throughout the entire company—in scientific work, administration, or what not.

So an advanced degree is not a royal road to anything at Du Pont, Bill. But when coupled with proved abilities, an advanced technical degree is unquestionably helpful to a man in research and development work. It often gives him a chance to demonstrate his abilities more rapidly.

Are you interested in research work?

About 2000 Du Pont scientists are currently engaged in research, aided by some 3500 other employees. Laboratory facilities of the highest quality are available at the Du Pont Experimental Station near Wilmington, and elsewhere throughout the country. Full information about research work at Du Pont is given in "The Story of Research." Write for your copy of this free 28-page booklet to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Building, Wilmington, Delaware.

DU PONT

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

WATCH "CAVALCADE OF AMERICA" ON TELEVISION

STRESS and STRAIN...

The Ag on his first visit to the city was fascinated by the asphalt streets. Scraping his feet on the hard surface, he said: "Well, I can't blame 'em for building a town here. The ground's too derned hard to plow anyhow."

A sweet old lady, always eager to help the needy, spied a particularly sad looking old man standing on a street corner. She walked over to him, pressed a dollar into his hand and said, "Chin up."

The next day, on the same corner, the sad old man shuffled up to the lady and slipped ten dollars into her hand.

"Nice picking," he said in a low voice. "He paid nine to one."

New Parson: "I'm certainly glad to have such a wonderful congregation."

Parishioner: "And we're delighted to have you. You have been so informative. Why, we didn't know what sin was before you came."

A meddling old English woman accused one of the villagers of having reverted to drink because, "with her own eyes," she had seen his wheelbarrow standing outside the tavern.

The accused man made no verbal defense; but the same evening, he placed his wheelbarrow outside her door and left it there all evening.

We've gotten a special report from the South. Seems that the drought down there is so bad the trees are going to the dogs.

A small boy was very interested in watching a baldheaded man scratch the fringe of hair around the side of his head. After some time the boy said in a loud whisper, "Say, Mister, you'll never catch him that way. Why don't you run him out in the open?"

A grouch went into a barber shop and said to the barber; "I want a shave, see? I don't want a haircut, I don't want a shampoo, I don't want a shine, I don't want a manicure and I don't want any chit-chat. See? I just want a shave. You understand?"

"Lather?" asked the barber.

A farmer and a professor were sharing a seat on a train. It was getting lonesome so the farmer started a conversation and they soon became a friendly pair.

"Let's have a game of riddles to pass the time," said the professor, "if I have a riddle that you can't guess you give me one dollar or vice versa."

"All right," replied the farmer, "but since you are better educated than I am, do you mind if I give you only fifty cents?"

"OK," replied the professor, "You go first."

"Well, what animal has three legs walking and two legs flying?"

"I don't know. Here's your dollar. What's the answer?"

"I don't know either. Here's your fifty cents," answered the farmer.

Three gentlemen appeared at the railroad station, alcoholically propelled. As they reached the platform, the train began to move, and all three staggered for it. The station cop and a porter managed to bundle two of them aboard but they didn't get the third gent on the train. He stood sadly on the platform watching it disappear.

"Too bad, mister," the cop said. "Wish you could have gone aboard."

"Yes," replied the man, "and my frens'll be sorry too. They were seeing me off."

Asked what he did for recreation if and when he got to town, one of those long, lean Texas cowboys reluctantly confessed, "I most always go dancin' if there is one."

"Why nobody'd guess you knew how to dance," the questioner exclaimed in surprise.

"Heck, I can't dance a lick," the cowboy admitted, "but boy I sure like to hold 'em while they do!"

The devil sends the blessed winds

To raise the skirts on high;

But God is just—he sends the dust

To blind the wicked eye!

Too many of us are at the metallic age—silver in our hair, gold in our teeth . . . and lead in our pants.

Dinner guest at an Engineering Banquet: "Will you pass the nuts, Prof?"

Preoccupied Professor: "I suppose so, but I really should flunk most of them."

Overheard in the WIDOW *office: "The editor just hung himself!"*

"Omigosh! Have you cut him down?"

"Heck no, he isn't dead yet."

Westbound Rio Grande freight in Ruby Canyon of Colorado River.

The freight rolls away an hour sooner

because photography cuts yard bookkeeping

The Denver and Rio Grande Western Railroad microfilms its waybills in minutes, cuts running schedules, saves costs in train idling time.

You don't find a Rio Grande freight idling at the terminal while waybills are copied by hand. Instead, Recordak Microfilming copies them. Then they're put aboard and the train is off in just about one-fifth the time it used to take, thus saving hours of valuable crew and train time. Then the wheel reports are made up from the films and teletyped ahead.

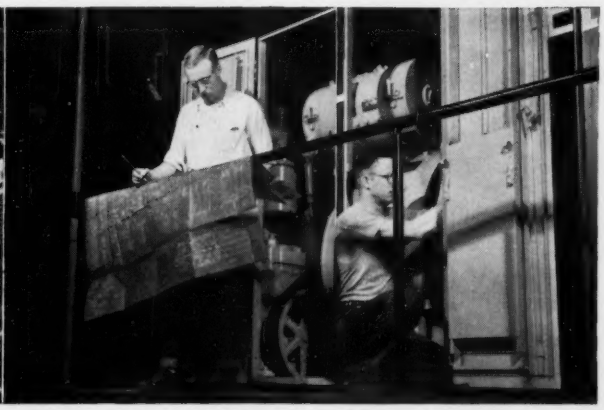
Railroading is but one of over a hundred types of businesses now saving money, time and space with microfilming. It is one of the fast growing and widely used ways photography works for industry.

Small businesses and large are finding that photography helps in simplifying routine procedures, in product design, in personnel relations. It improves production, saves time and cuts costs.

Graduates in the physical sciences and in engineering find photography an increasingly valuable tool in their new occupations. Its expanding use has also created many challenging opportunities at Kodak, especially in the development of large-scale chemical processes and the design of complex precision mechanical-electronic equipment. Whether you are a recent graduate or a qualified returning service man, if you are interested in these opportunities, write to Business & Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N.Y.

Eastman Kodak Company, Rochester 4, N.Y.

CHARLES SNYDER, R.P.I., (center) adjusting 5250 triple-unit d-c mill motor for use in a steel mill.



Engineers RICHARD RENK, IOWA STATE, (left) and ALLEN FRINK, CATHOLIC UNIV., make last-minute check on 1600-hp diesel-electric switcher before it is moved to test track.

THEY'RE "GOING PLACES" AT GENERAL ELECTRIC

Like these young men pictured here, hundreds of scientists, engineers, chemists, physicists and other college graduates are "getting ahead" fast at General Electric . . . . and they are working on projects with the assurance that their contributions are meaningful and important.

They are moving up rapidly because at General Electric a world of opportunity awaits the college man of today—a world limited only by his own ability and interest. The variety of General Electric products and the diversity of the Company's operations provide virtually unlimited fields of opportunity and corresponding rewards, both materially and in terms of personal satisfaction to young men who begin a G-E career.

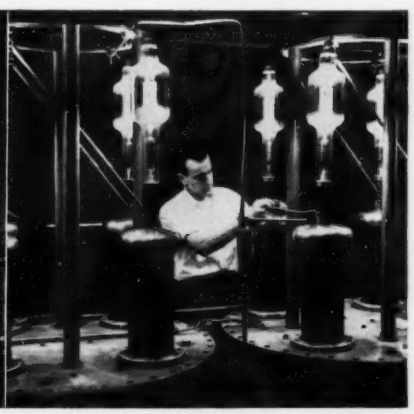
New developments—in silicones, electronics, semi-conductors, gas turbines, atomic power, and others—springing from G-E research and engineering, are creating exciting new opportunities, and are giving college graduates the chance of finding satisfying, rewarding work.

And by placing prime importance on the development of talent and skill, developed through G-E training programs and broadened through rotational job programs, and by providing incentives for creative minds, General Electric is hurrying young men into success in an industry that is devoted to serving all men through the ever-increasing and ever-widening uses for electricity, man's greatest servant.

If you are interested in building a career with General Electric see your college placement director for the date of the next visit of the General Electric representative on your campus. Meanwhile, for further information on opportunities with General Electric write to College Editor, Dept. 2-123, General Electric Company, Schenectady 5, New York.

Test engineers E. K. VON FANGE, U. OF NEB., (left) and R. E. LOVE, U. OF TEXAS, work on stacker and stapler built by them for homework project.

Physicist ROGER DEWES, BROOKLYN POLY., working with scintillation counter in G.E.'s Engineering Laboratory.



ANTHONY TERZANO, PRATT INSTITUTE, checks connections on direct-current rectifier which charges 7,500,000-volt impulse generator in G.E.'s new High-voltage Laboratory.

GENERAL ELECTRIC